

Mapbook

Assessing Community Risk in Relation
to Coastal and Inland Natural Hazards
in Maine's Washington County and
Greater East Grand Region

January 2026

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Front and back cover images provided by Reilee Gunsher, CSS Inc./NOAA NCCOS.

Disclaimer

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.



Top left: Flea market items for sale, Machias dike. Credit: Chloe Fleming, CSS Inc./NOAA NCCOS.

Top right: Working waterfront in coastal Maine. Credit: Amy Freitag, NOAA NCCOS.

Bottom left: In-progress logging operations, Washington County, Maine. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.

Bottom right: Road and bridge renovation, Washington County, Maine. Credit: Chloe Fleming, CSS Inc./NOAA NCCOS.

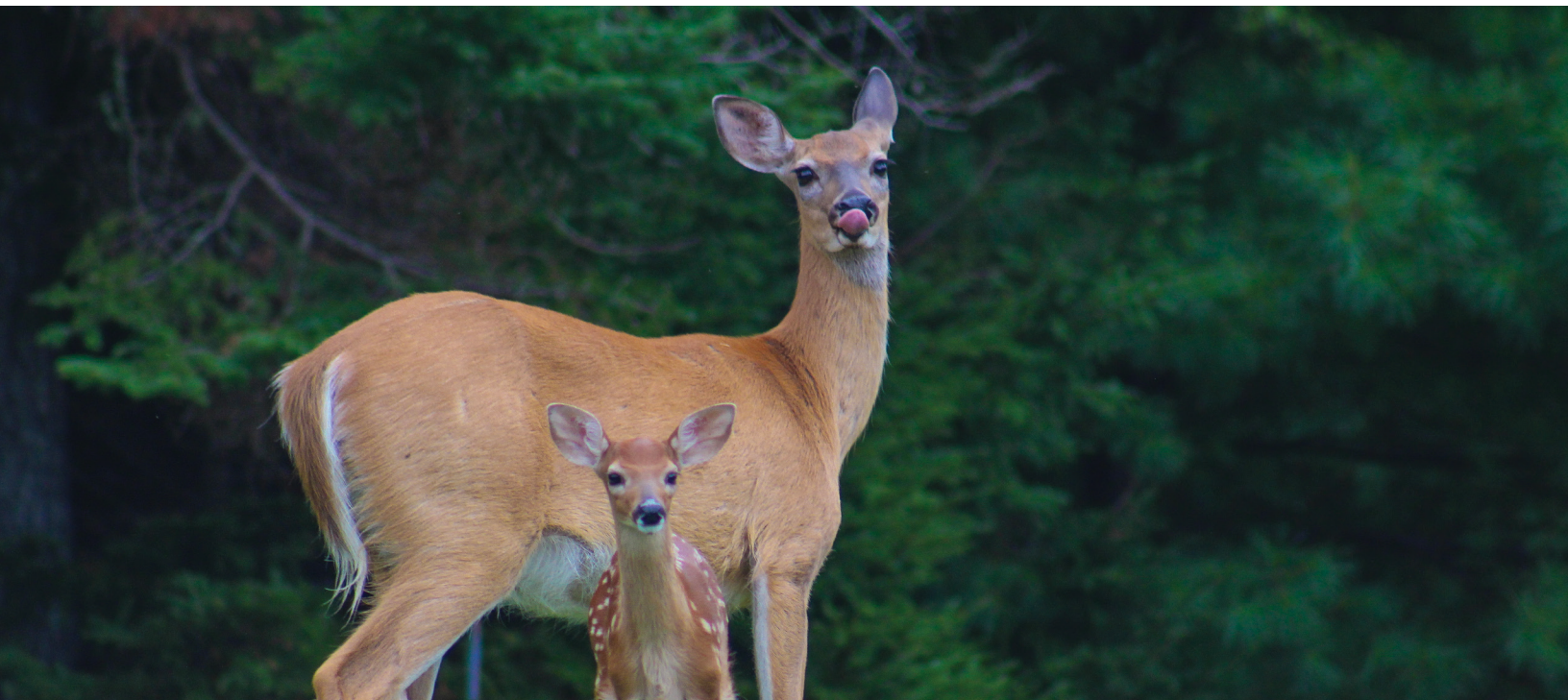
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Bear Lodge, Indian Township. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.

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Doe and fawn in Washington County, Maine. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.

1 Introduction

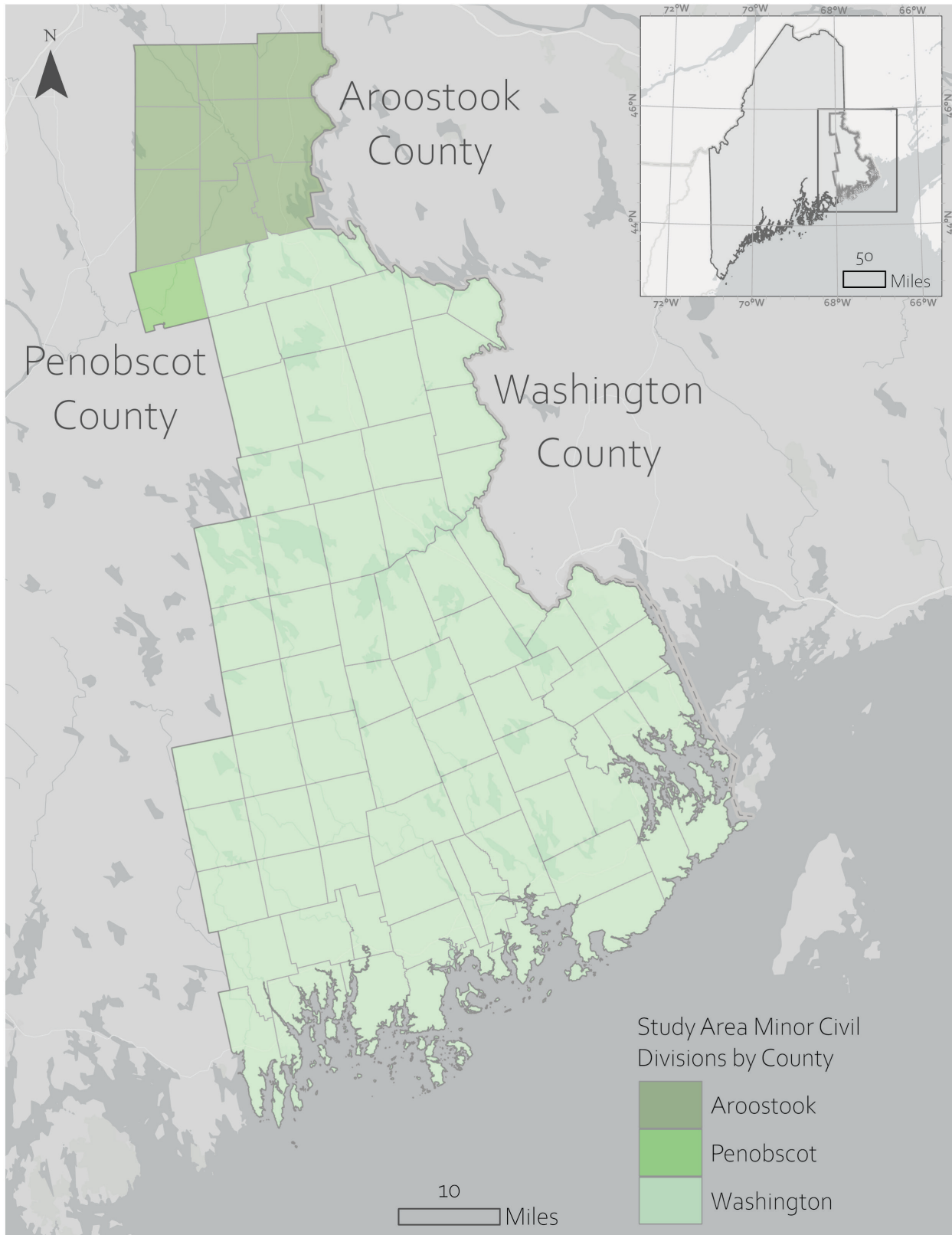
Coastal communities are at risk from numerous environmental hazards including storms, flooding, erosion, and wildfire. Some areas are more at-risk than others due to a variety of factors. The National Centers for Coastal Ocean Science partnered with the Sunrise County Economic Council and other local partners to **assess community risk** in relation to coastal and inland natural hazards in **Maine’s Washington County and Greater East Grand Region**. Due to its rural and widely dispersed population, this region is particularly susceptible to infrastructure failures and community isolation during individual or compounded hazard events.

This assessment used both **indicators and indices to evaluate environmental hazards and assess relative risk** across the study area. These tools are commonly applied in community risk assessments to measure, track, and communicate levels of exposure and risk. Indicators are specific, measurable variables that reflect key aspects of a system or condition. Indices combine one or more indicators into a single, comparative score, allowing for standardized measurement across geographic areas.

All indicators and indices were derived from the most recent, publicly available data. Indicators were normalized from 0–1 and combined into composite indices, where appropriate. Final values were categorized using statistical quantile breaks to illustrate relative differences across the study area. This approach **supports local prioritization and informed decision making for planning and adaptation**.



Wild blueberries, Maine. Credit: Reilee Gunshur, CSS Inc./NOAA NCCOS.



The NCCOS risk assessment study area of Maine’s Washington County and Greater East Grand Region, including parts of Aroostook and Penobscot Counties. Minor civil divisions, including towns, townships, plantations, and Native American reservations, are shown unlabeled.

In addition to the full study area, this mapbook also displays detailed views for three example areas chosen by local partners: **Danforth, Machiasport, and Roque Bluffs**. Additional areas can be explored by zooming within the full study area maps or by exploring the archived datasets at Harvard Dataverse (<https://doi.org/10.7910/DVN/SIC18E>) and www.data.gov.

This mapbook presents key assessment findings organized to support informed decision-making:

- **Sections 2–3** identify areas at risk of community isolation and present co-occurring relationship maps.
- **Sections 4–5** evaluate road-stream crossing risk and infrastructure risk to specific hazards.
- **Sections 6–7** detail individual hazard profiles, population density, and critical infrastructure.
- **Sections 8–9** provide a glossary of key terms and a summary of methods.

Each section includes a brief overview to guide interpretation. For technical documentation and archived data supporting these findings, see Section 9.



Jasper Beach, Maine. Credit: Chloe Fleming, CSS Inc./NOAA NCCOS.

2 Community Isolation Risk

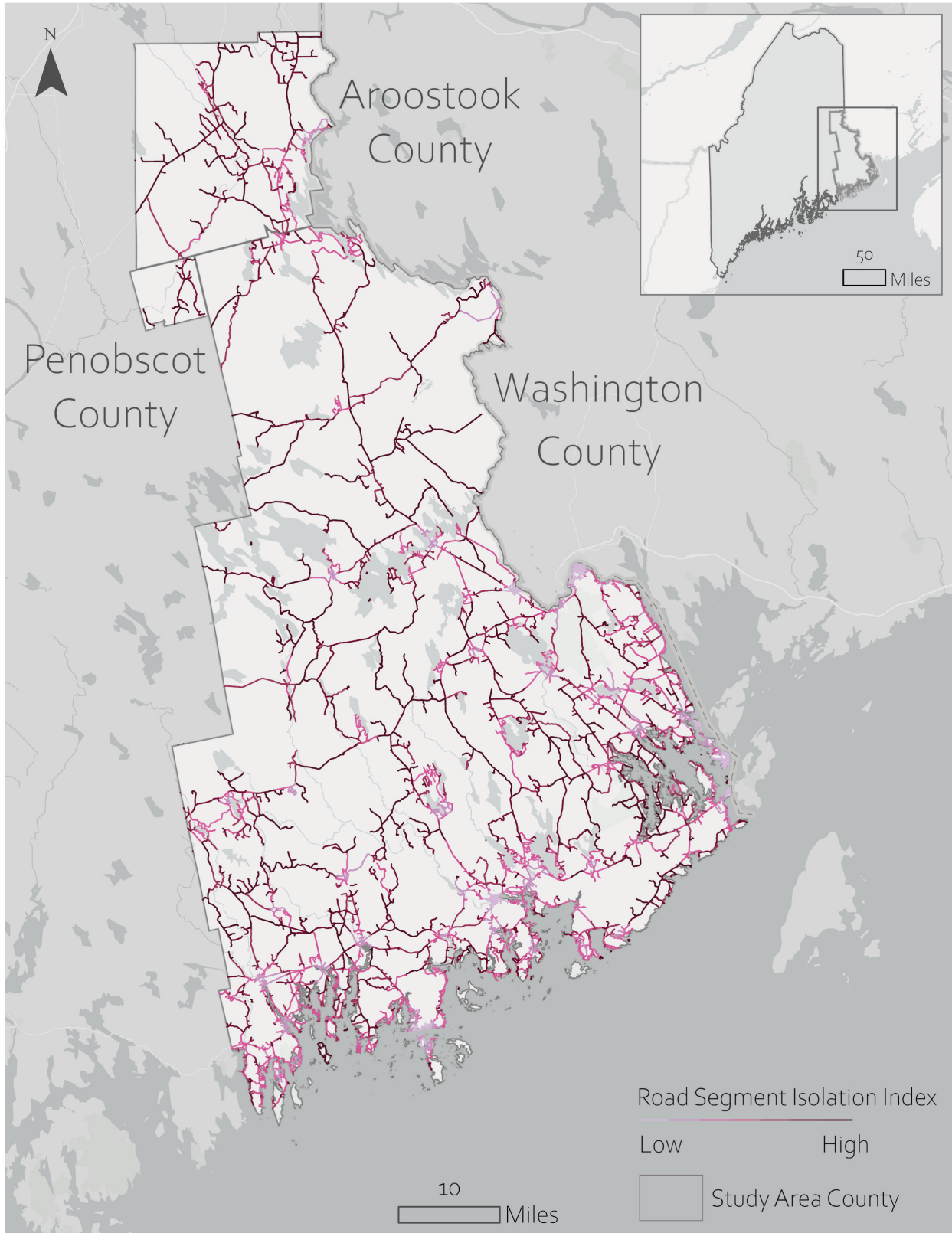
This section presents an analysis of community isolation through 1) a road segment isolation index, 2) hazard road isolation risk indices, and 3) service area isolation risk indices. All maps relied upon a routable road network that incorporated features such as accurate connectivity, distances, directionality, speed limits, and network topology.

Road segment isolation was determined through a connectivity assessment, where fewer connections increased the likelihood of transportation disruption during a hazard event. These scores were then combined with hazard values (Section 6) to estimate relative road isolation risk per hazard. Lastly, service area isolation risk assessed proximity and access to key critical infrastructure under hazard conditions to identify populations at increased risk of isolation. All map values are unitless index values relative to the study area.

This section helps decision makers identify **communities more likely to be isolated during hazard events and areas where critical services could be disrupted**, supporting targeted **planning and response efforts**.



Machias dike from northern side. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.

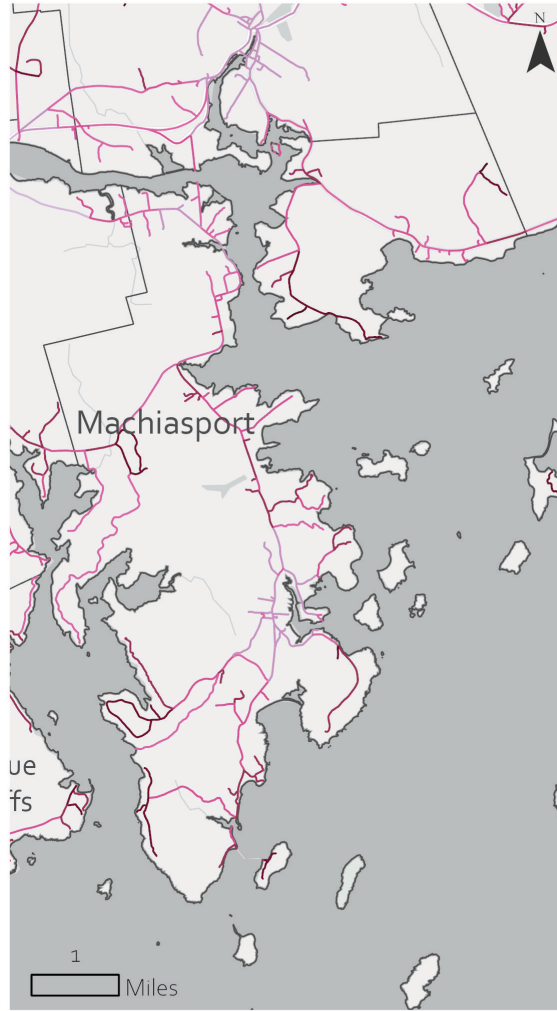


Road segment isolation index displaying road connectivity, with more isolated roads (less connectivity) due to road network characteristics shown in darker pink and less isolated roads (more connectivity) shown in lighter pink.

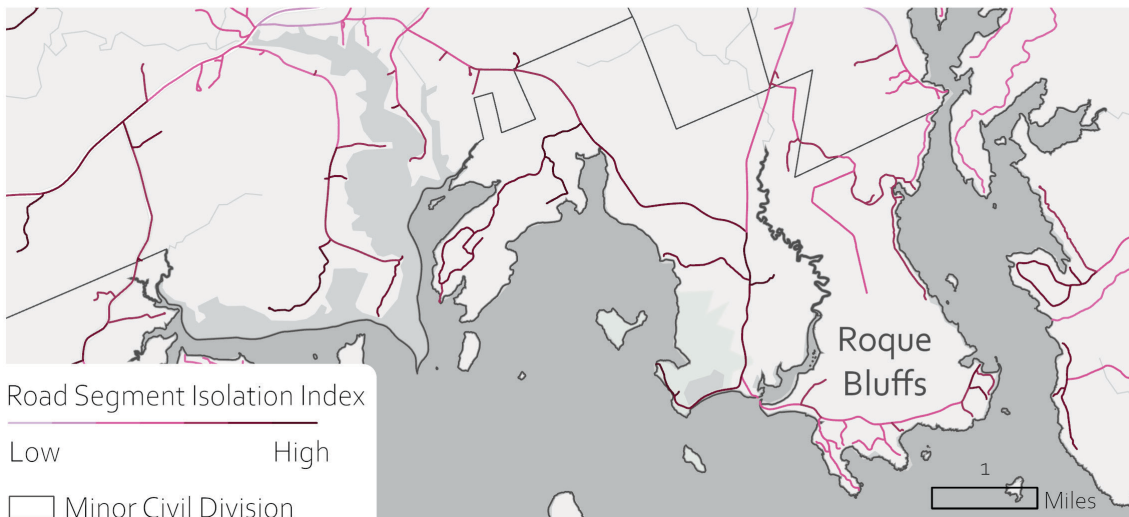
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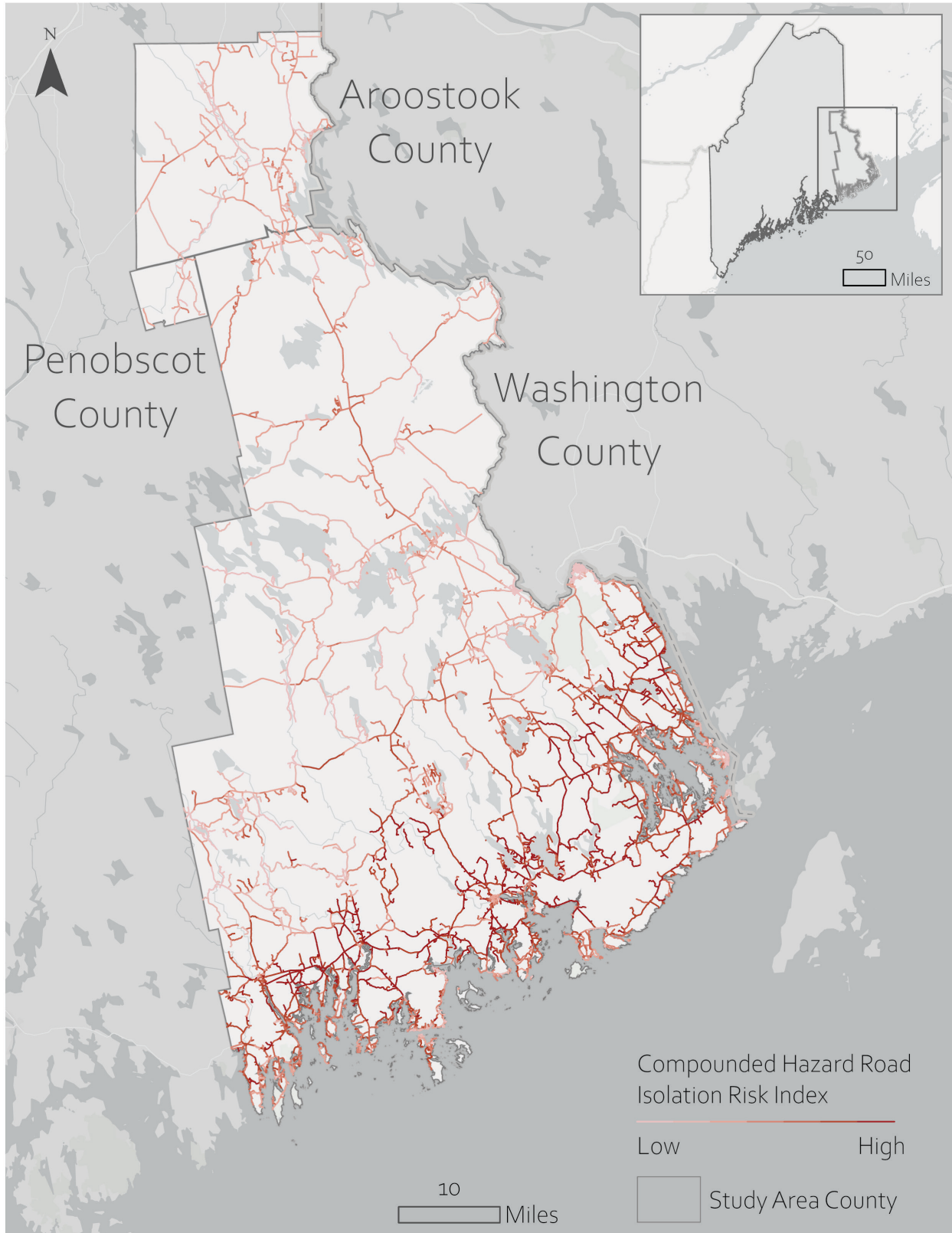
ROQUE BLUFFS



ROQUE BLUFFS

Road Segment Isolation Index
 Low High
 □ Minor Civil Division

Road segment isolation index shown for Danforth, Machiasport, and Roque Bluffs. Higher isolation due to road network characteristics is shown in darker pink, and lower isolation is shown in lighter pink.



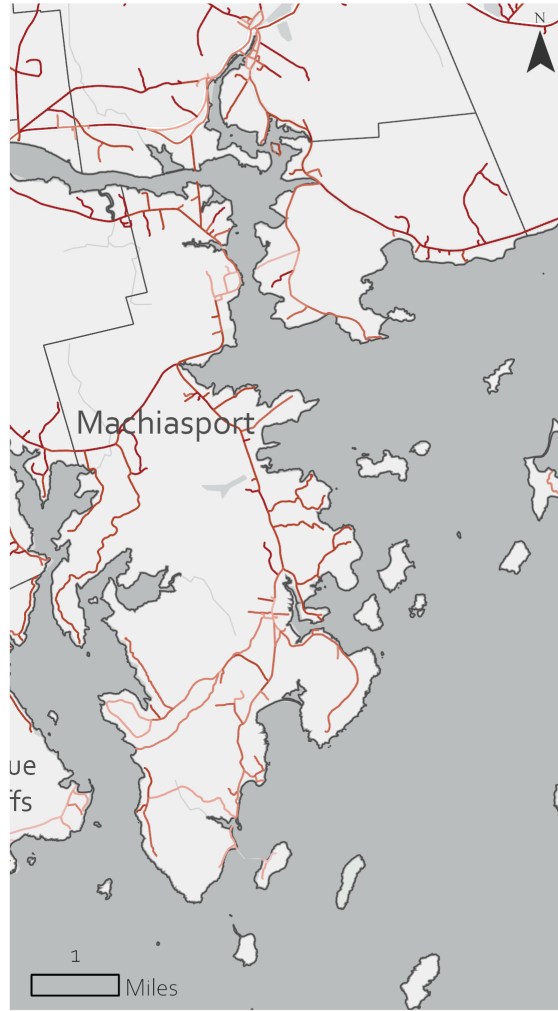
Compounded hazard road isolation risk index from the combined scores of the stormwater flooding, winter ice storm, wildfire, and road-stream crossings road isolation risk indices.* Dark red road segments have a higher risk of being isolated by compounded hazards and underlying road network features than light red road segments.

*The storm surge hazard index was omitted from this analysis due to limited spatial overlap between the storm surge hazard index and the routable road network .

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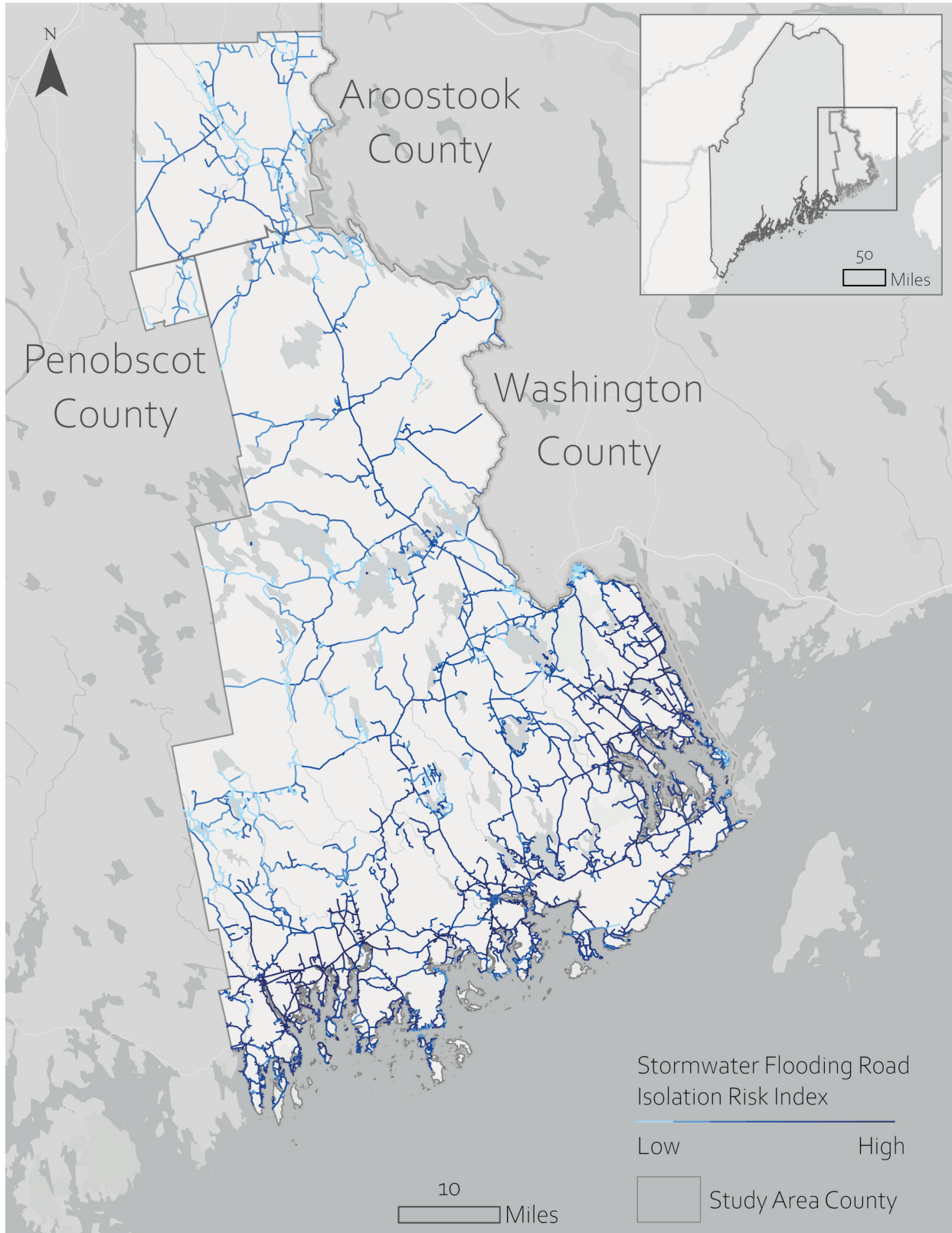


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Compounded Hazard Road Isolation Risk Index
 Low High
 Minor Civil Division

Compounded hazard road isolation risk index from the combined scores of the stormwater flooding, winter ice storm, wildfire, and road-stream crossings road isolation risk indices, * shown for Danforth, Machiasport, and Roque Bluffs. Dark red road segments have a higher risk of being isolated by compounded hazards and underlying road network features than light red road segments.

*The storm surge hazard index was omitted from this index due to limited spatial overlap between the storm surge hazard index and the routable road network.

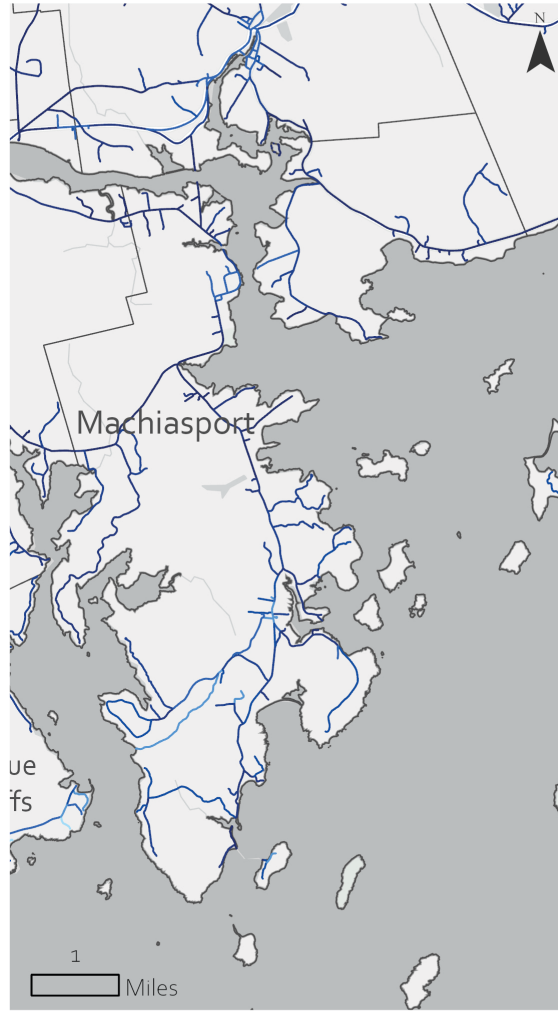


Stormwater flooding road isolation risk index from the combination of each road segment’s road isolation risk index score and its stormwater flood hazard index score. Road segments intersecting zones of increased stormwater flood hazard have higher exposure scores. Darker blue roads have a higher risk of being isolated from stormwater flooding and underlying road network characteristics than lighter blue roads.

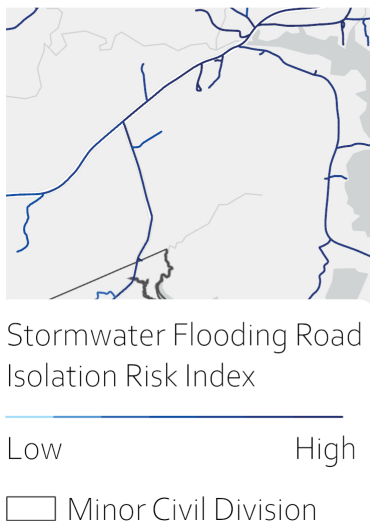
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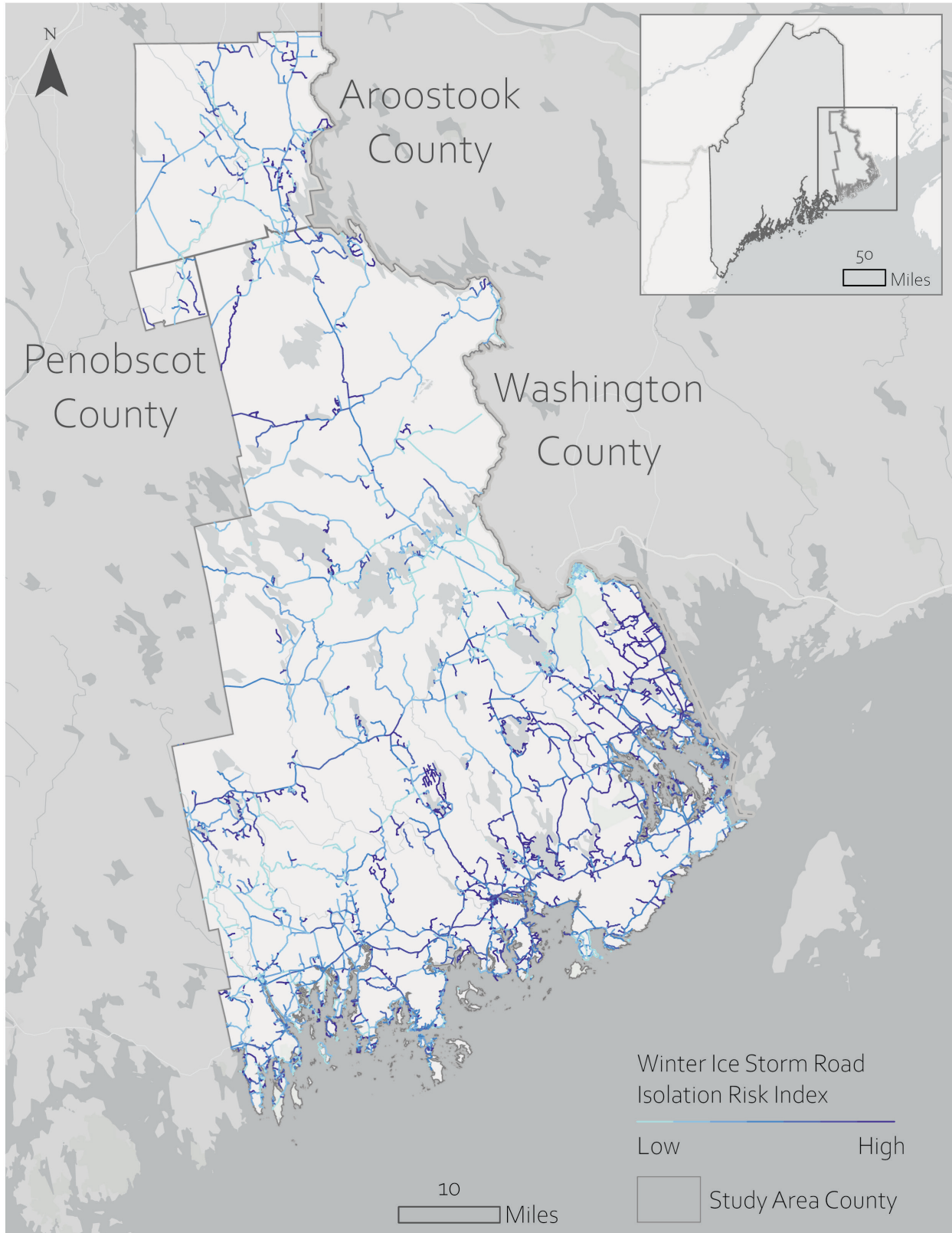
Stormwater Flooding Road Isolation Risk Index

Low High

Minor Civil Division

ROQUE BLUFFS

Stormwater flooding road isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker blue roads have a higher risk of being isolated from stormwater flooding and underlying road network characteristics than lighter blue roads.

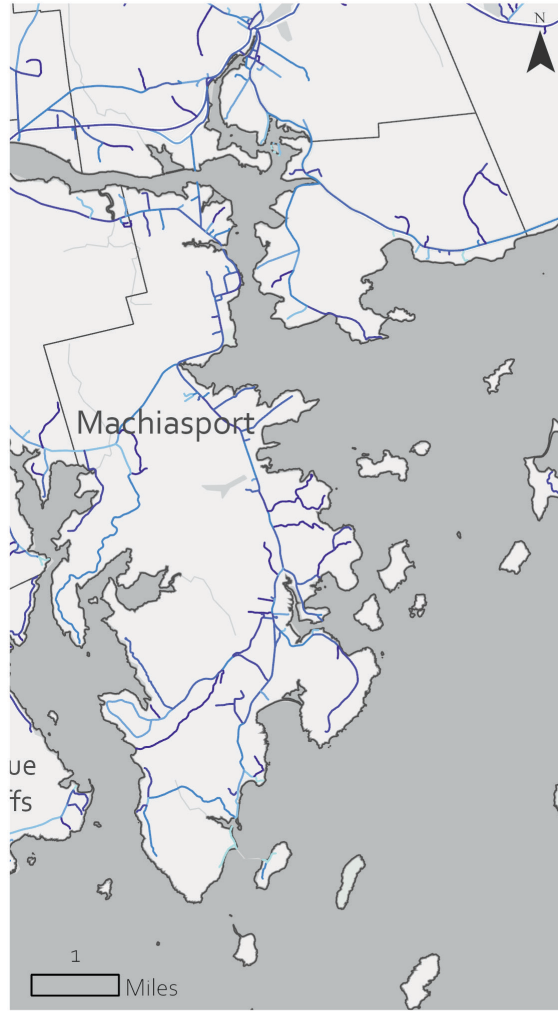


Winter ice storm road isolation risk index from the combination of each road segment's road isolation risk index score and its winter ice storm hazard index score. Road segments intersecting zones of increased winter ice storm hazard have higher exposure scores. Darker blue roads have a higher risk of being isolated from winter ice storms and underlying road network characteristics than lighter blue roads.

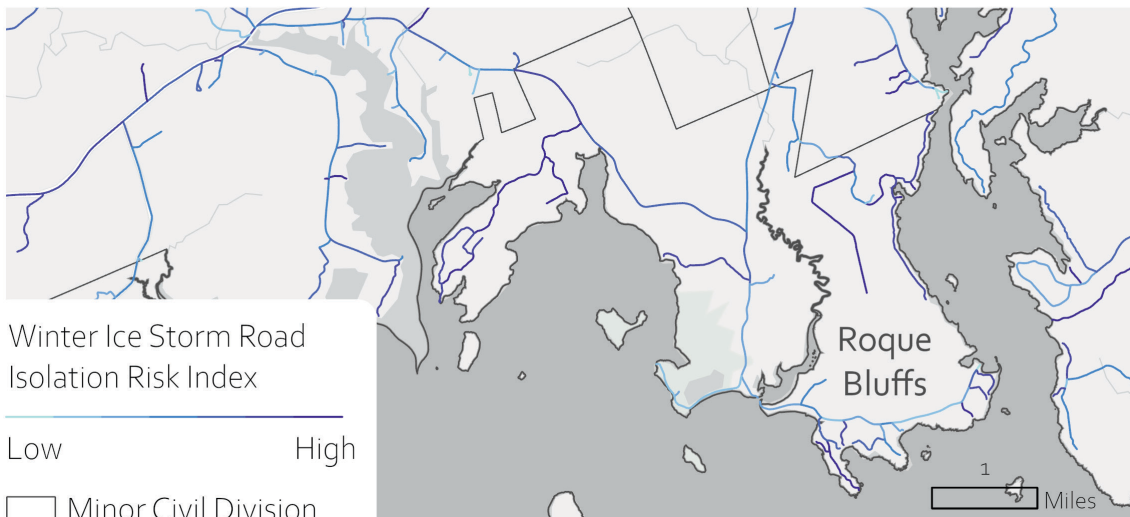
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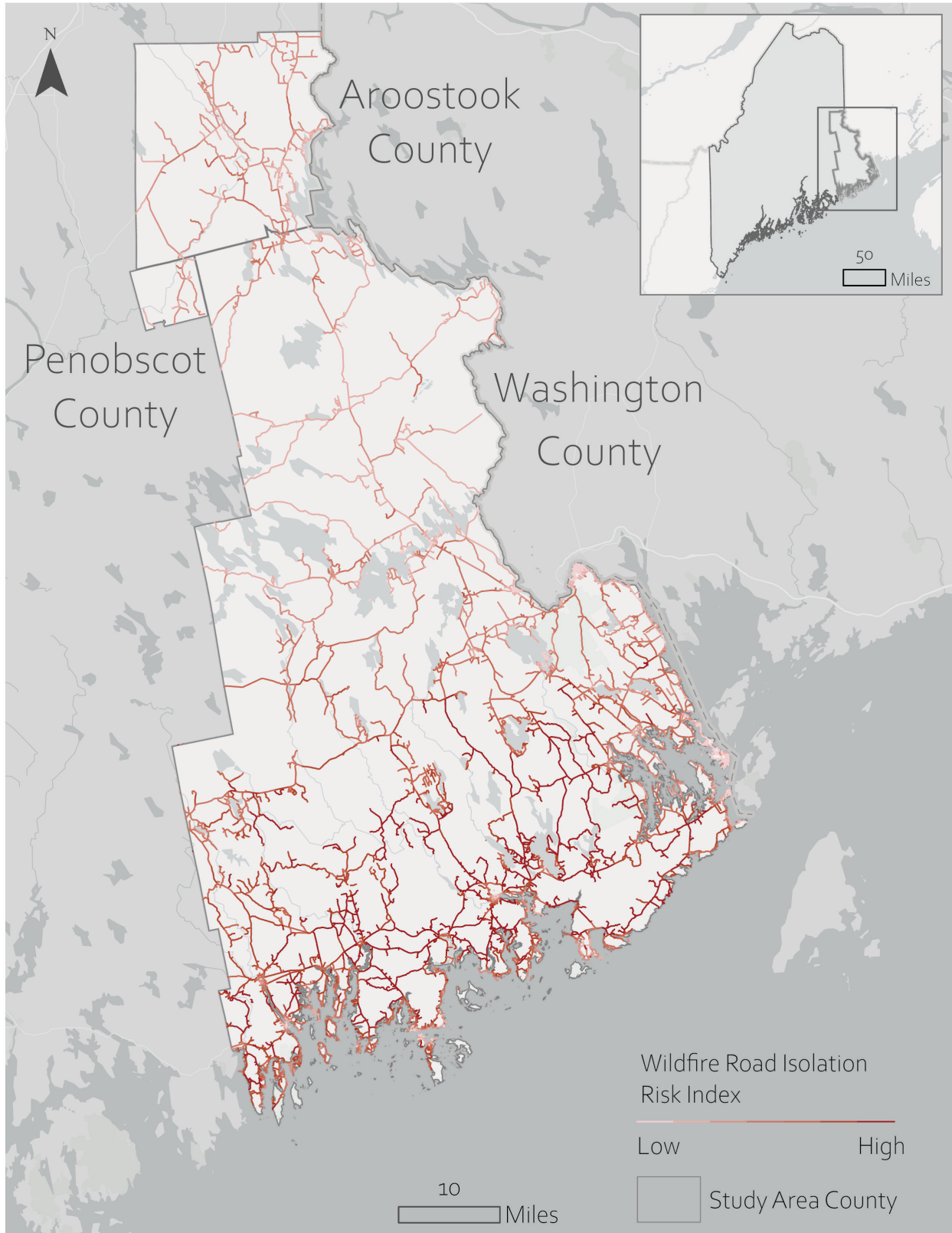
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Winter Ice Storm Road Isolation Risk Index
 Low High
 Minor Civil Division

Winter ice storm road isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker blue roads have a higher risk of being isolated from winter ice storms and underlying road network characteristics than lighter blue roads.

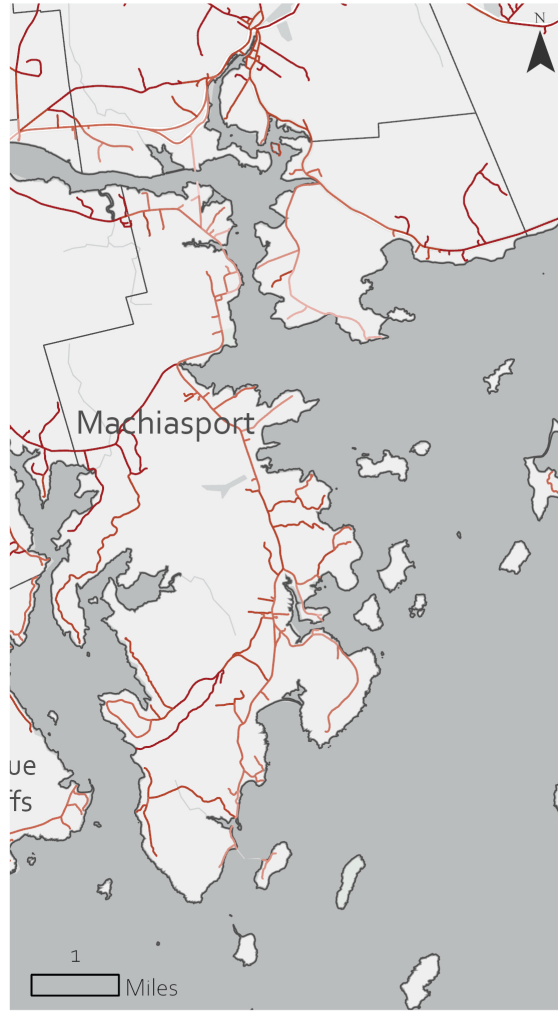


Wildfire road isolation risk index from the combination of each road segment’s road isolation risk index score and its wildfire hazard index score. Road segments intersecting zones of increased wildfire hazard have higher exposure scores. Darker red roads have a higher risk of being isolated from wildfire and underlying road network characteristics than lighter red roads.

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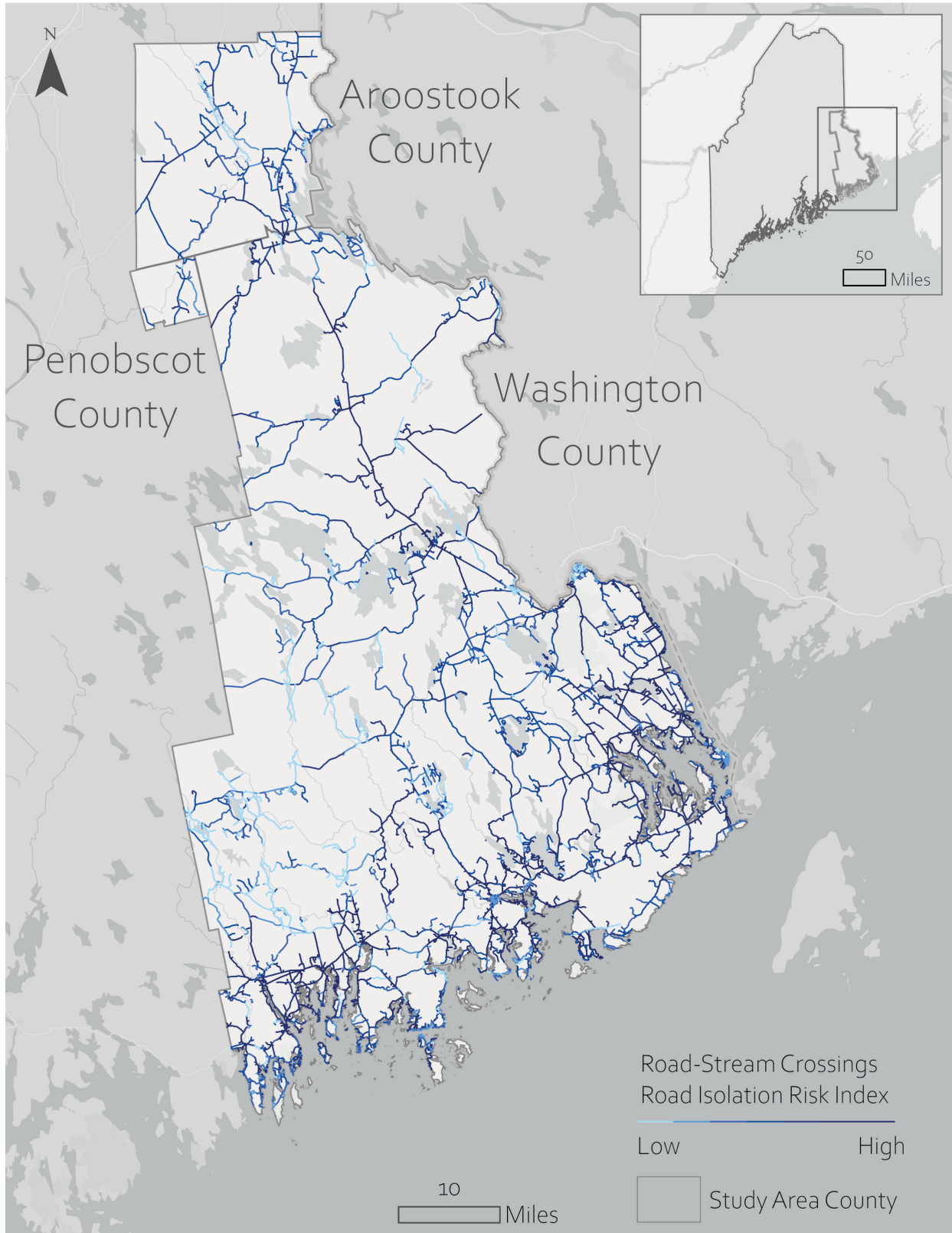
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Wildfire Road Isolation Risk Index
 Low High
 Minor Civil Division

Wildfire road isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker red roads have a higher risk of being isolated from wildfire and underlying road network characteristics than lighter red roads.

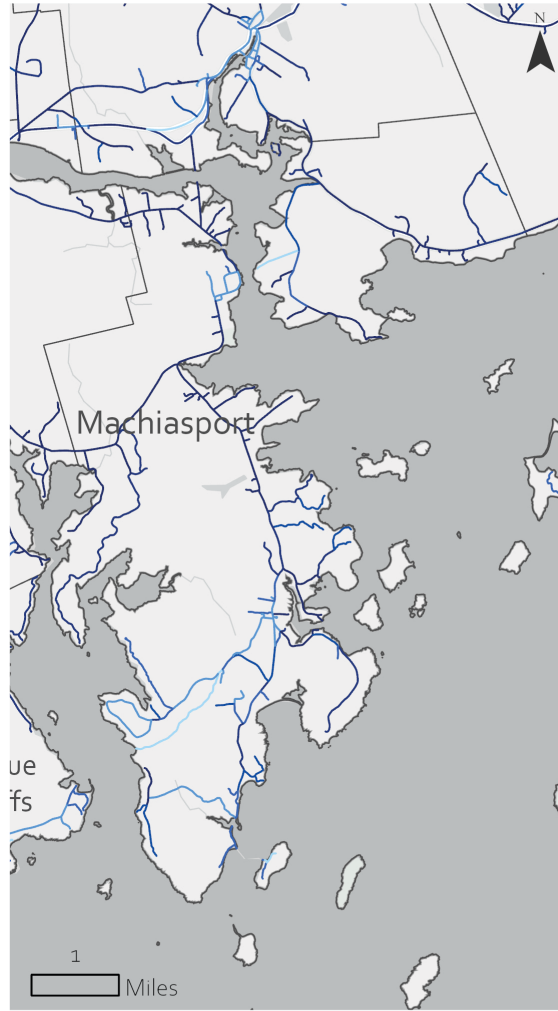


Road-stream crossings road isolation risk index from the combination of each road segment’s road isolation risk index score and its combined stormwater flooding and soil erosion hazard index score. Road segments intersecting zones of increased combined stormwater flooding and soil erosion hazard have higher exposure scores. Since higher exposure scores result in greater road-stream crossing risk, darker blue roads have a higher risk of being isolated due to impacts to road-stream crossings and underlying road network characteristics than lighter blue roads.

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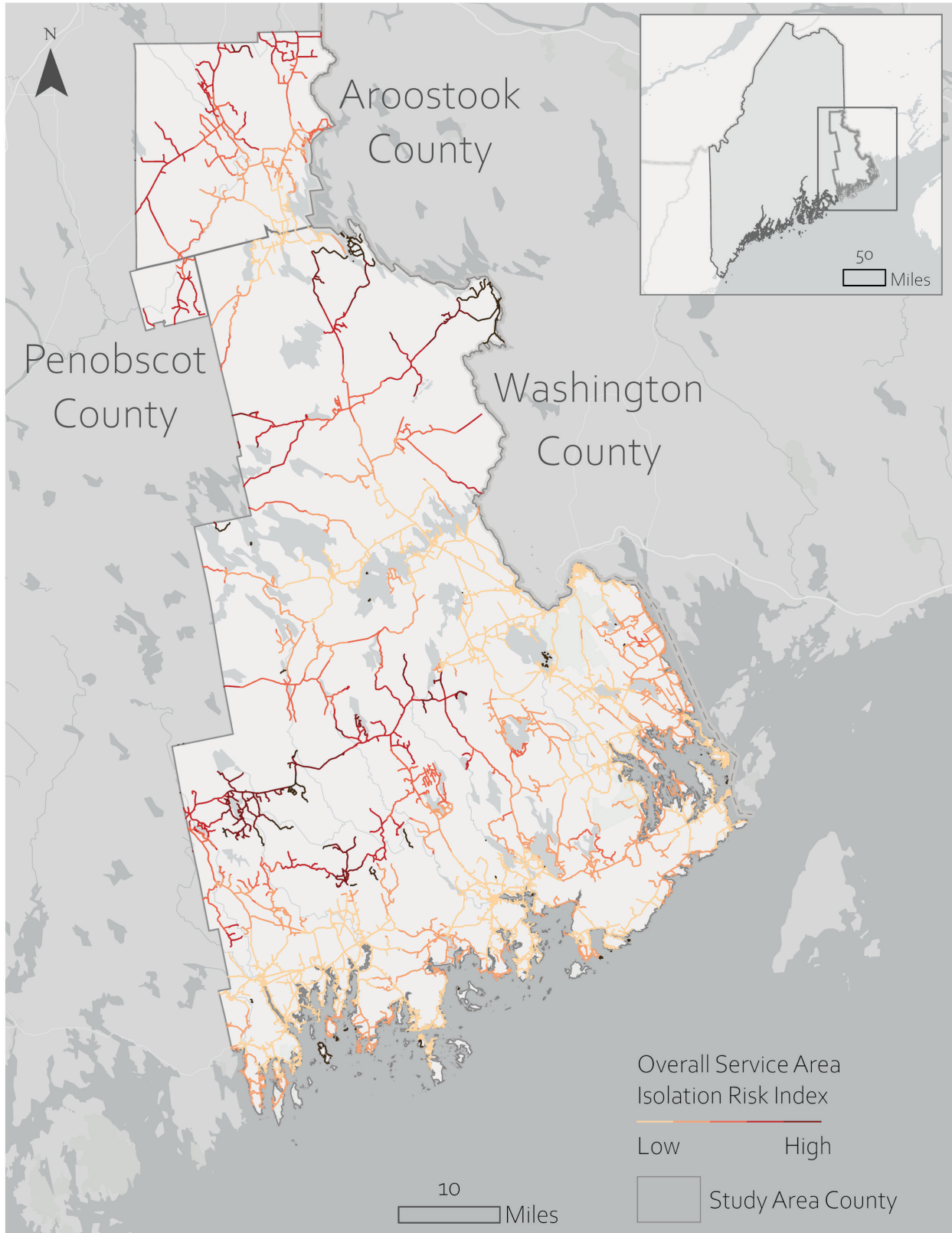
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Road-Stream Crossings
Road Isolation Risk Index
Low High
Minor Civil Division

Road-stream crossings road isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker blue roads are more likely to be isolated due to impacts to road-stream crossings and underlying road network characteristics than lighter blue roads.

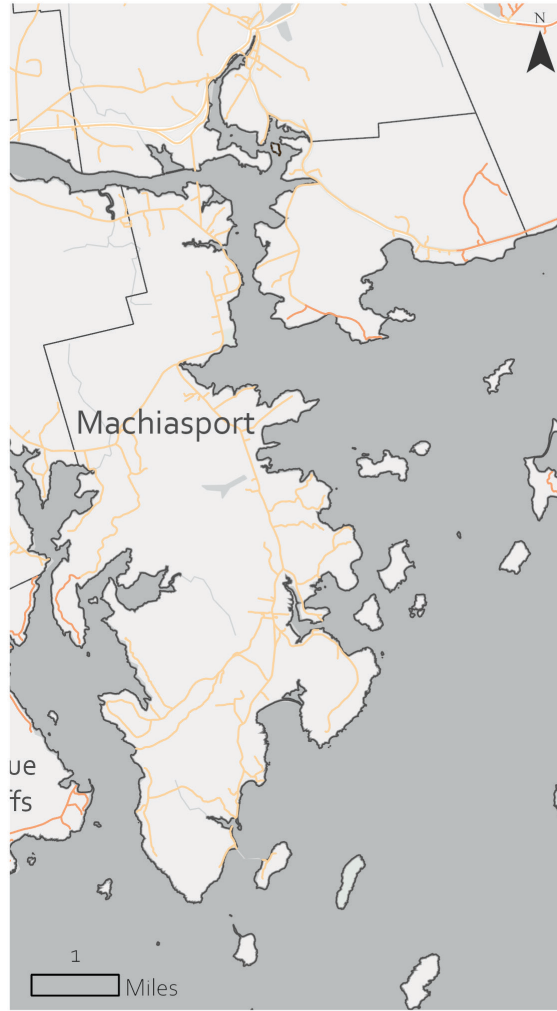


Overall service area isolation risk index, where road segments located farther from health, order and safety, and general service-related critical infrastructure have a higher likelihood of isolation under hazard conditions than those located closer, based on road network isolation and connectivity in 10km increments. See the following pages for more details. Darker road segments are more likely to be isolated from services, generally, than lighter colored road segments.

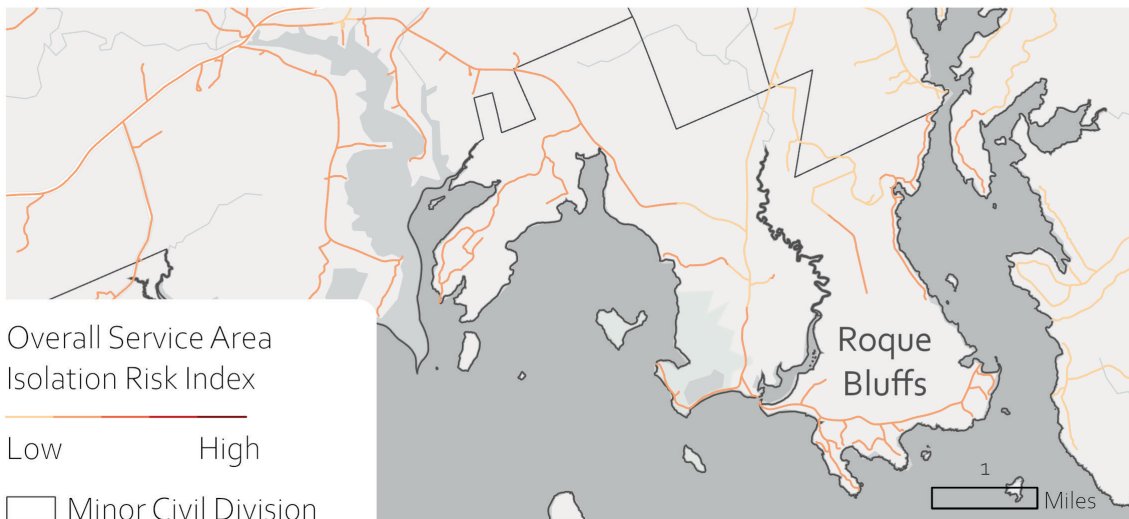
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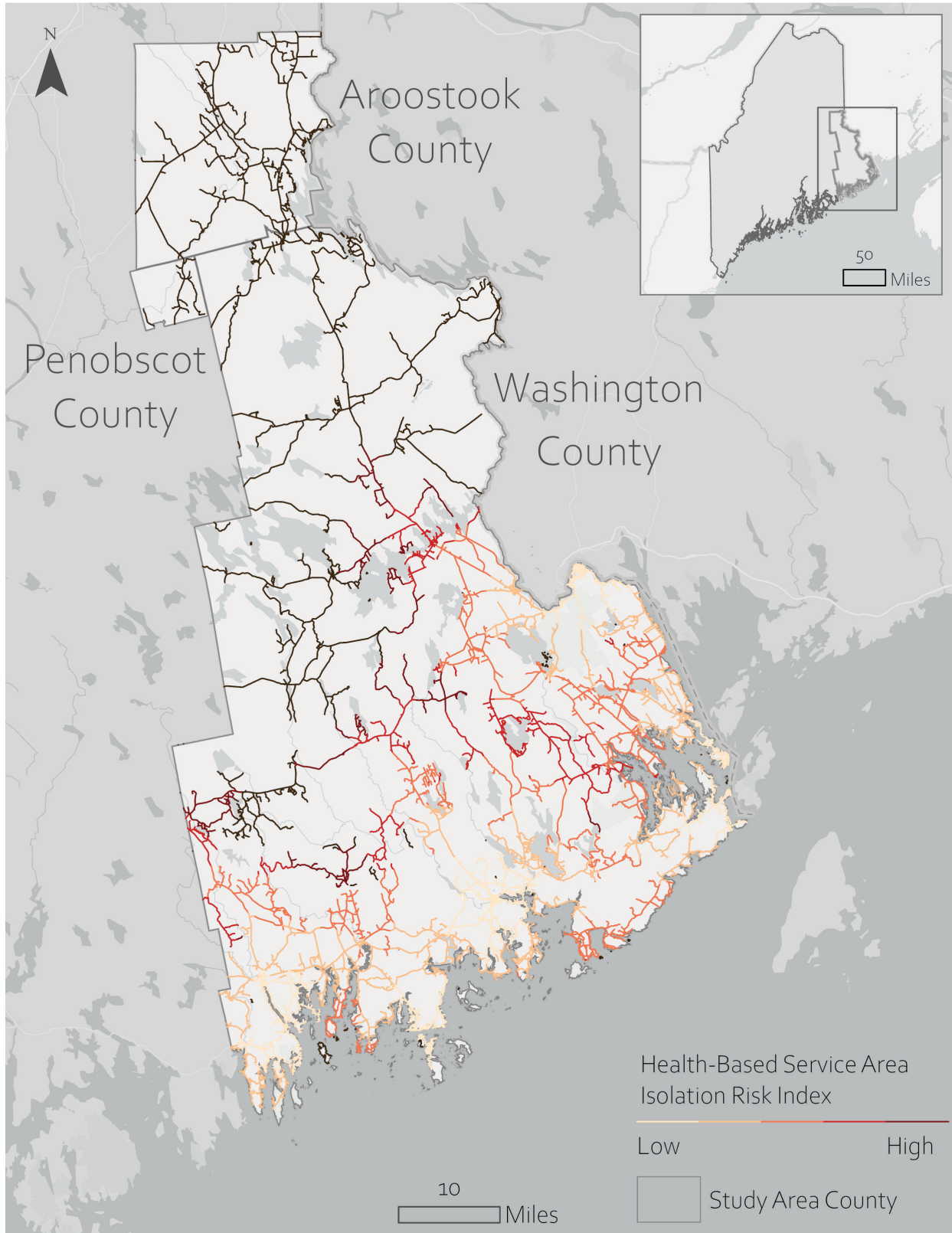
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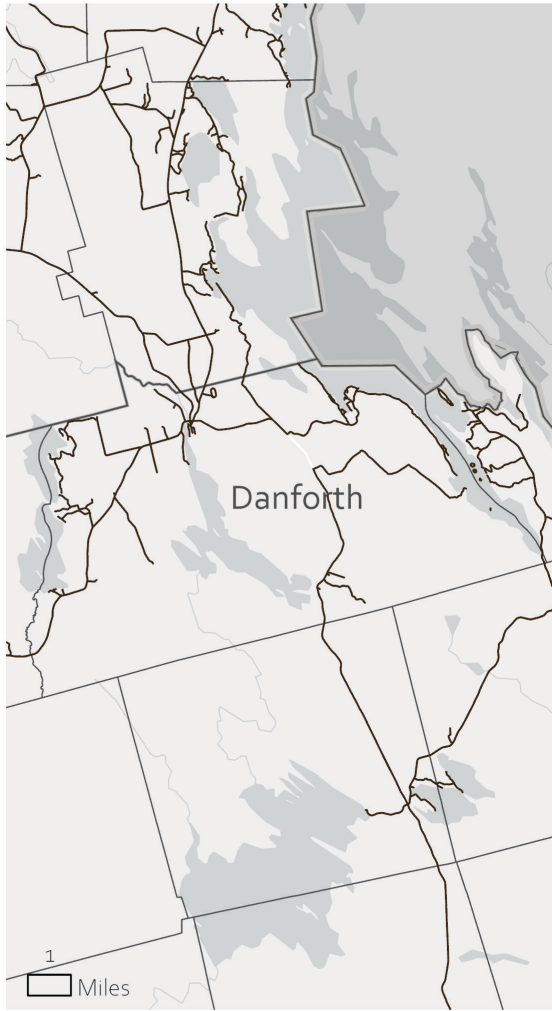
Overall Service Area Isolation Risk Index
 Low High
 Minor Civil Division

Overall service area isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker roads have a higher risk of isolation from services, generally, than lighter roads.

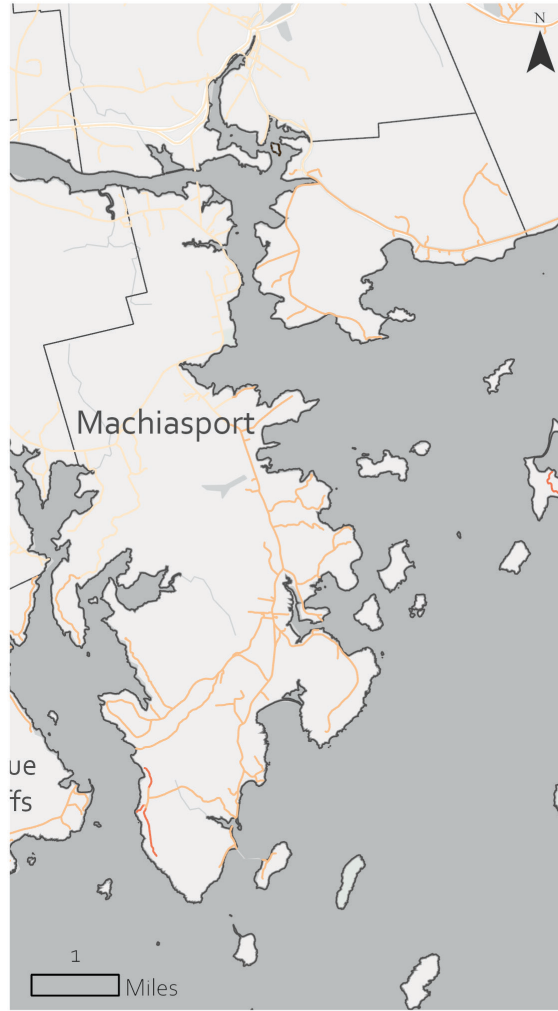


Health-based service area isolation risk index, where road segments located farther from health-related critical infrastructure have a higher likelihood of isolation under hazard conditions than those located closer, based on road network isolation and connectivity in 10km increments. Health-based services included hospitals, assisted living and nursing homes, recovery treatment health providers, psychiatry providers, and public health offices. Darker road segments are more likely to be isolated from health-based services than lighter colored road segments.

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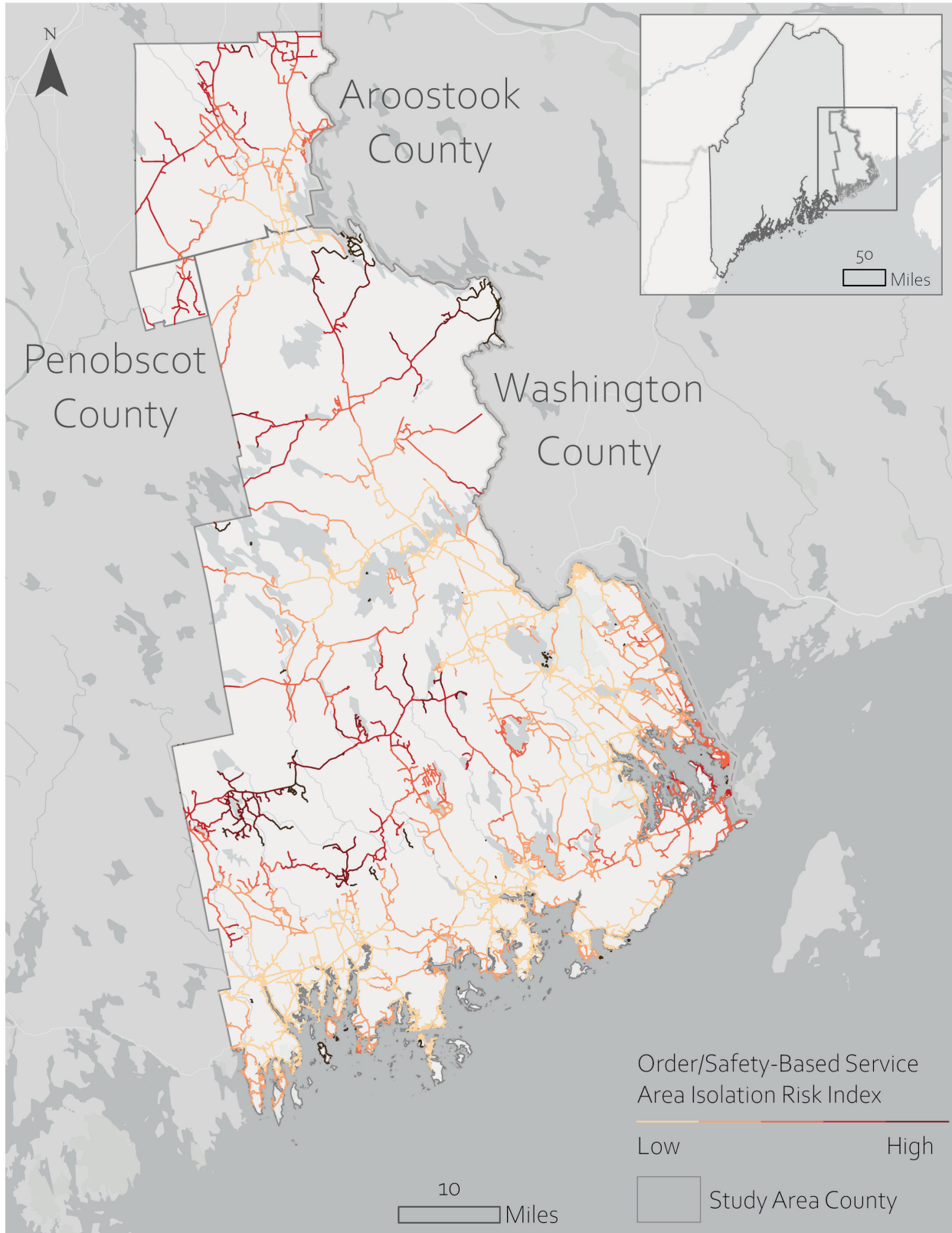
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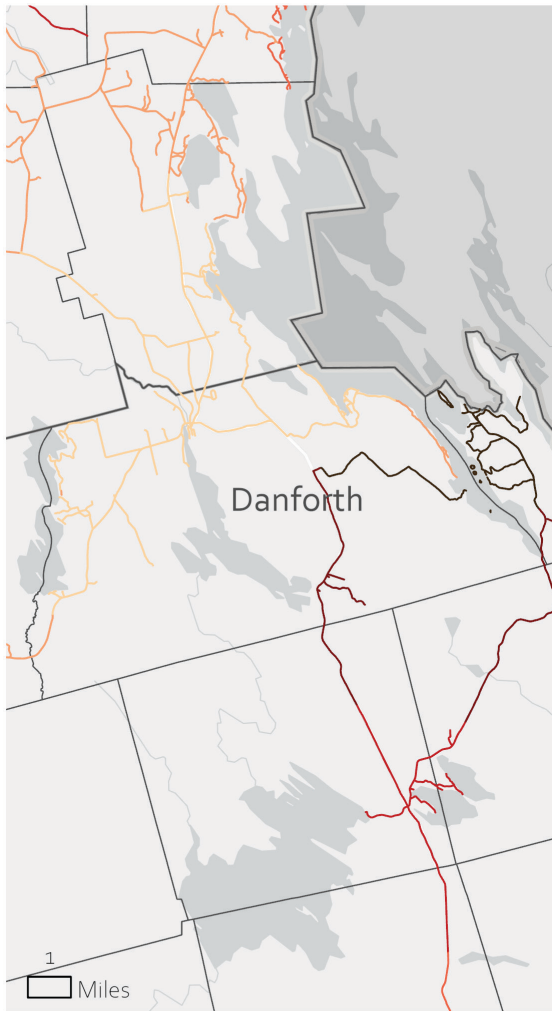
Health-Based Service Area Isolation Risk Index
 Low High
 Minor Civil Division

Health-based service area isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker roads have a higher risk of isolation from health-based services, such as hospitals and public health offices than lighter roads.

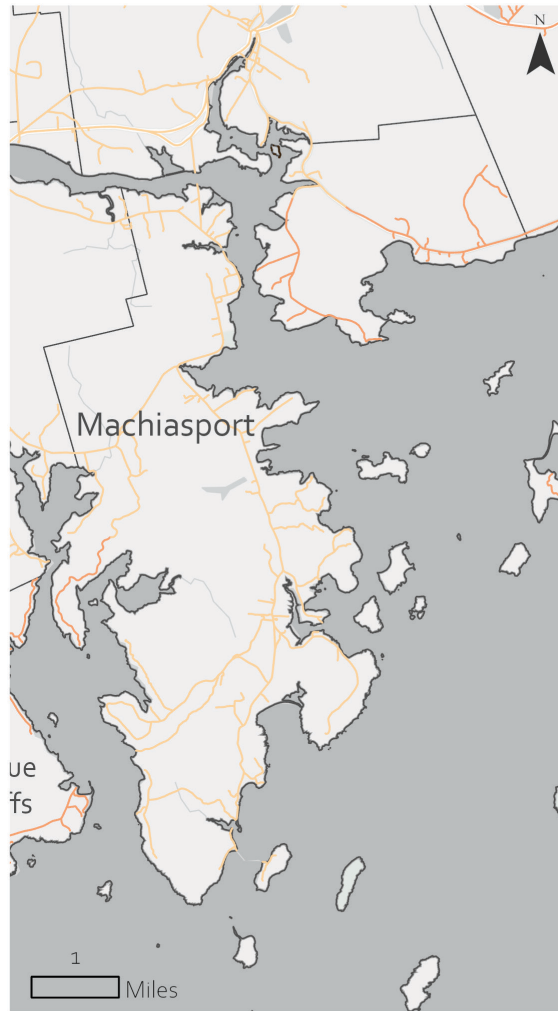


Order and safety-based service area isolation risk index, where road segments located farther from safety-related critical infrastructure have a higher likelihood of isolation under hazard conditions than those located closer, based on road network isolation and connectivity in 10-km increments. Safety-based services included emergency management and medical service facilities, fire stations, law enforcement, and correctional facilities. Darker road segments are more likely to be isolated from order and safety-based services than lighter colored road segments.

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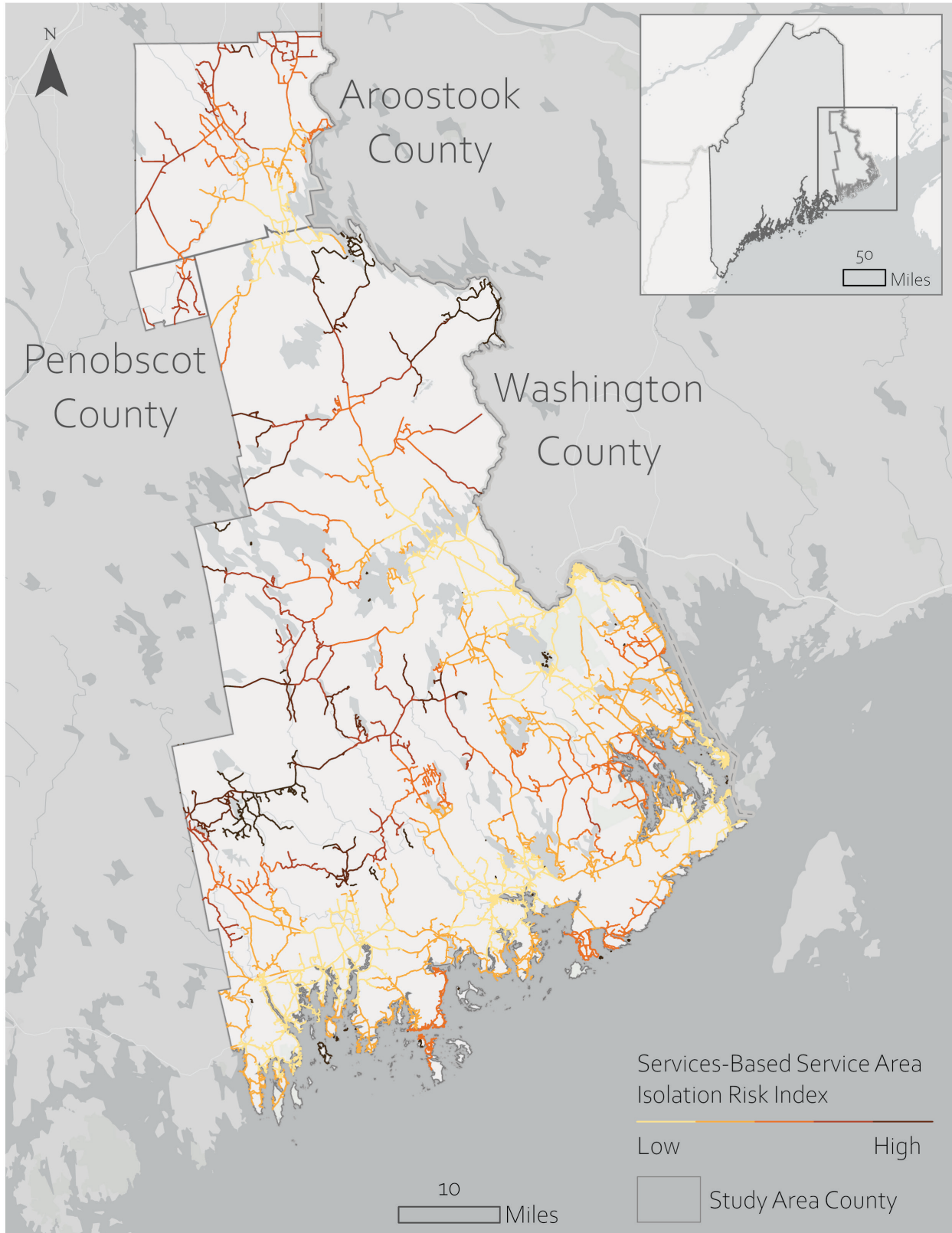
ROQUE BLUFFS



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Order/Safety-Based Service Area Isolation Risk Index
 Low High
 Minor Civil Division

Order and safety-based service area isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker roads have a higher risk of isolation from order and safety-based services, such as fire stations and law enforcement than lighter roads.

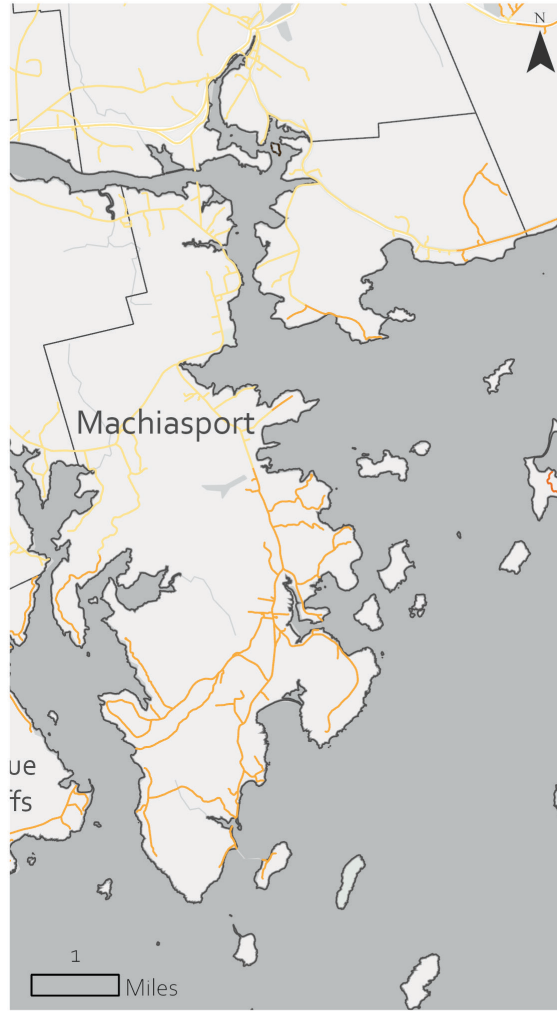


Services-based service area isolation risk index, where road segments located farther from general service-related critical infrastructure have a higher likelihood of isolation under hazard conditions than those located closer, based on road network isolation and connectivity in 10km increments. Service-based infrastructure included gas stations and grocery stores. Darker road segments are more likely to be isolated from general service-based services than lighter colored road segments.

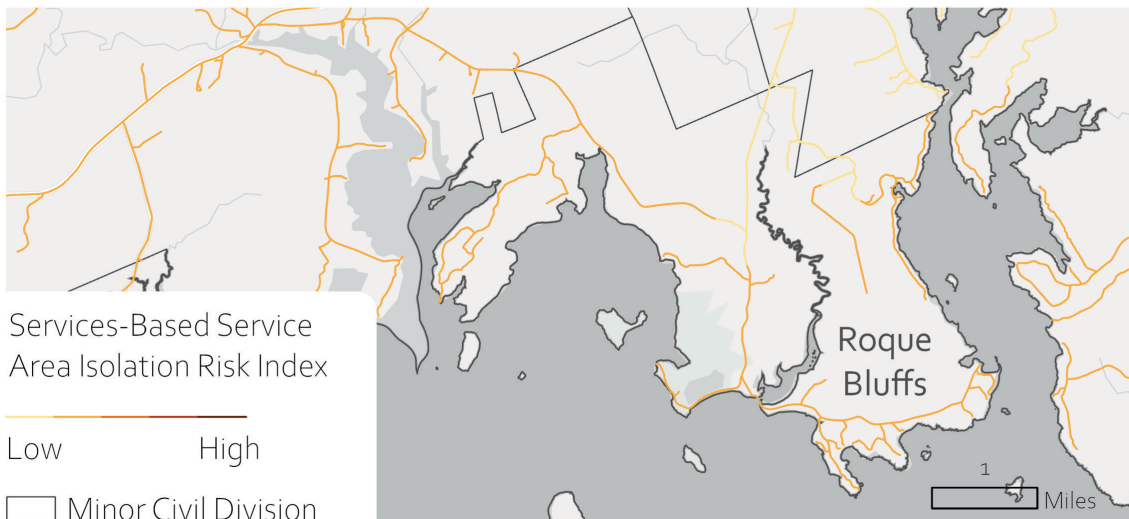
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Services-Based Service Area Isolation Risk Index
 Low High
 Minor Civil Division

Services-based service area isolation risk index for Danforth, Machiasport, and Roque Bluffs, where darker roads have a higher risk of isolation from gas stations and grocery stores than lighter roads.

3 Component Co-Occurrence

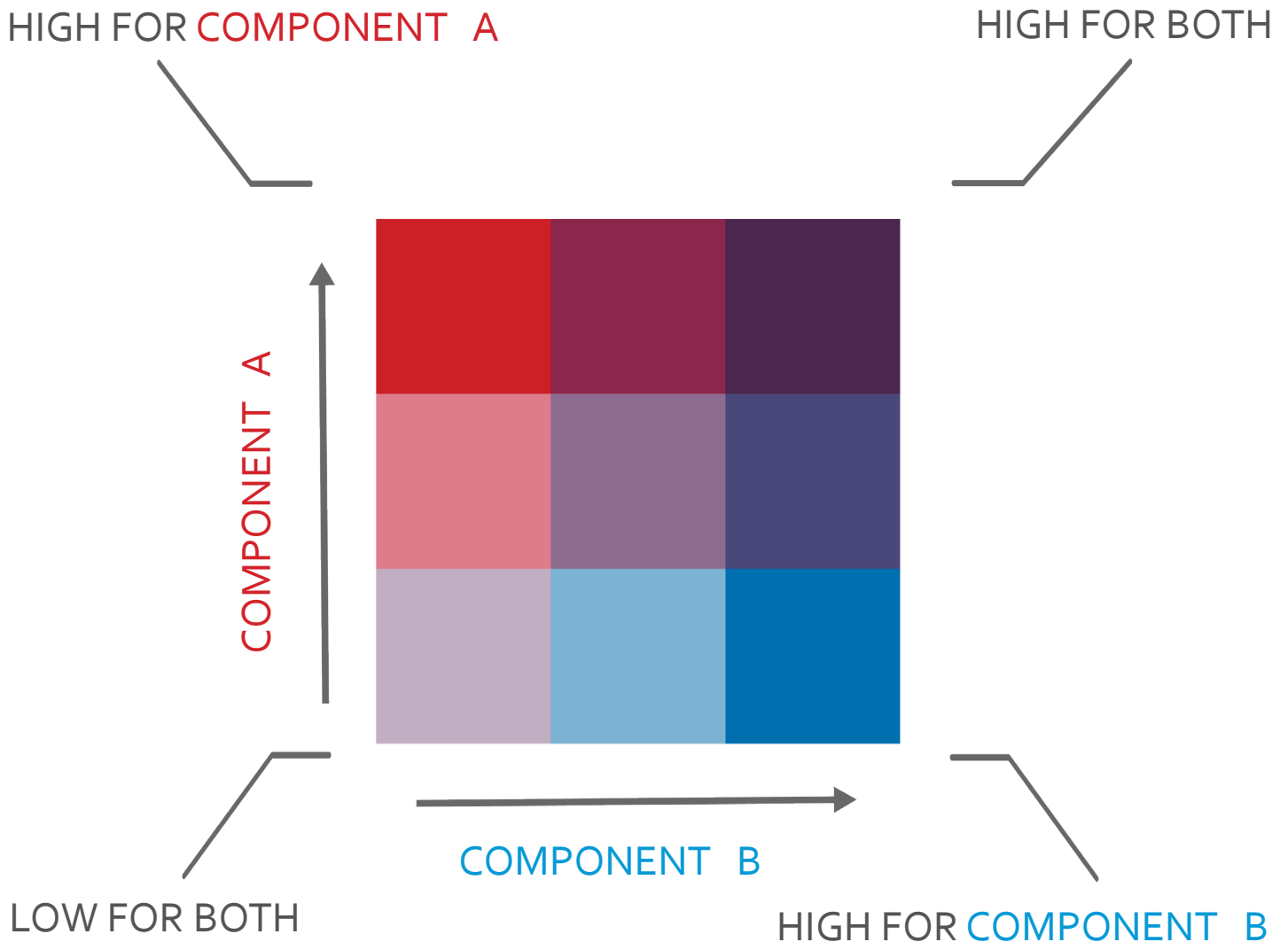
This section highlights areas of co-occurrence across the study area through relationship mapping. Using a mapping technique that shows two variables at once, these maps illustrate relationships between components, show how components change in relation to each other, and highlight where they overlap. This section first shows a relationship map legend and then presents intersections among population density and storm surge, stormwater flooding, winter ice storm, wildfire, and soil erodibility hazard. Component intersections were prioritized by local partners, and each index pair was symbolized to show the range from low to high values.

All map values are unitless index values relative to the study area, and all individual components are further explained in later sections.

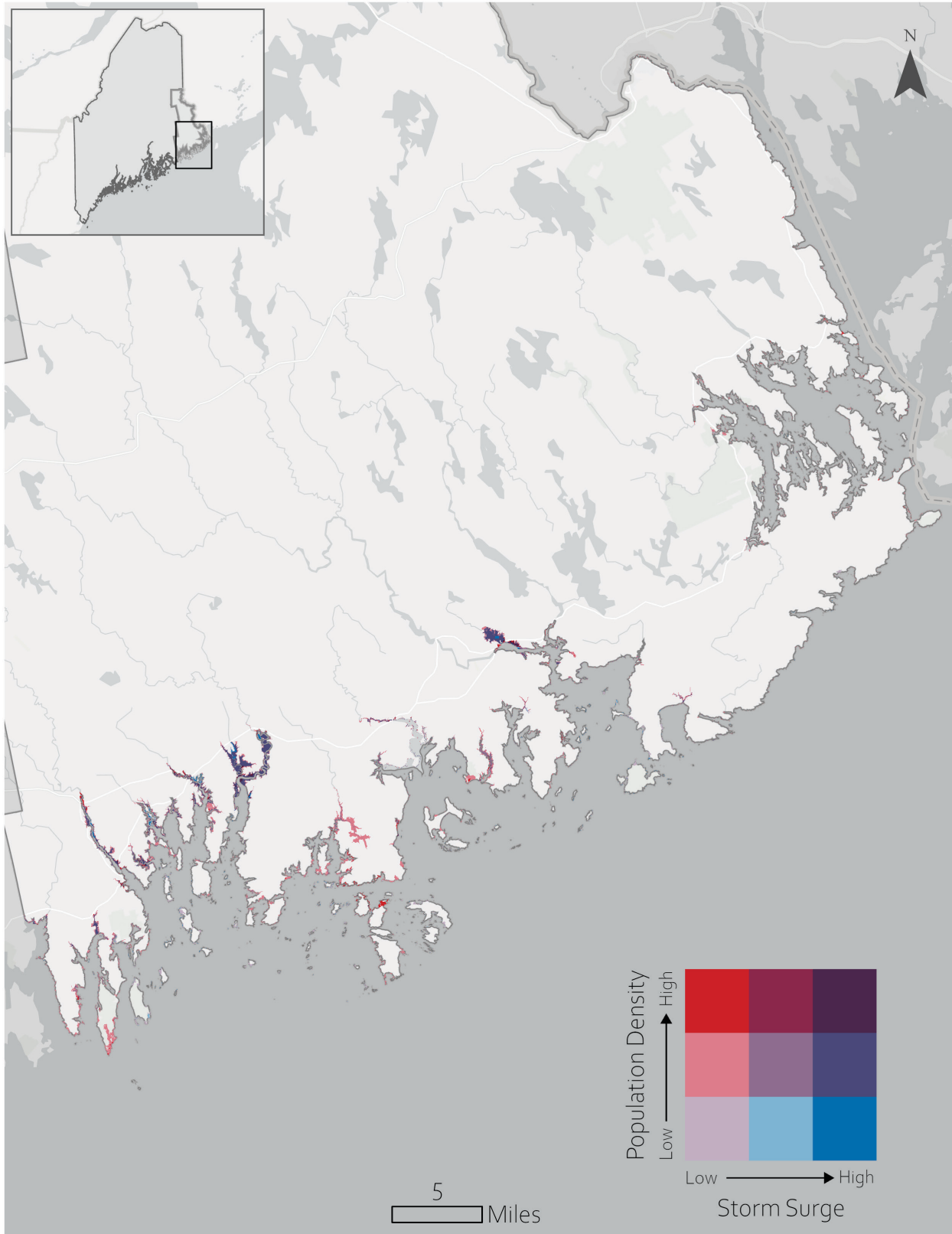
These maps create opportunities for decision makers by identifying **where key components overlap**, helping to **direct more localized investigation**, **prioritize actions**, and **plan more effectively**.



Trailhead at northern end of Machias dike along the estuary. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.



Relationship Map Legend: As one component's values increase from left to right (from lilac purple to light blue to deep blue), the other increases from bottom to top (from lilac purple to light red to crimson red). Each corner of the matrix represents an extreme combination of the two components. Eggplant purple areas indicate higher co-occurrence, while lilac purple areas signify lower co-occurrence. Red and blue areas indicate where one component has a higher value yet the other remains low. Lastly, maroon, medium purple, and violet areas have varying medium levels of co-occurrence. All scores are relative to the study area.

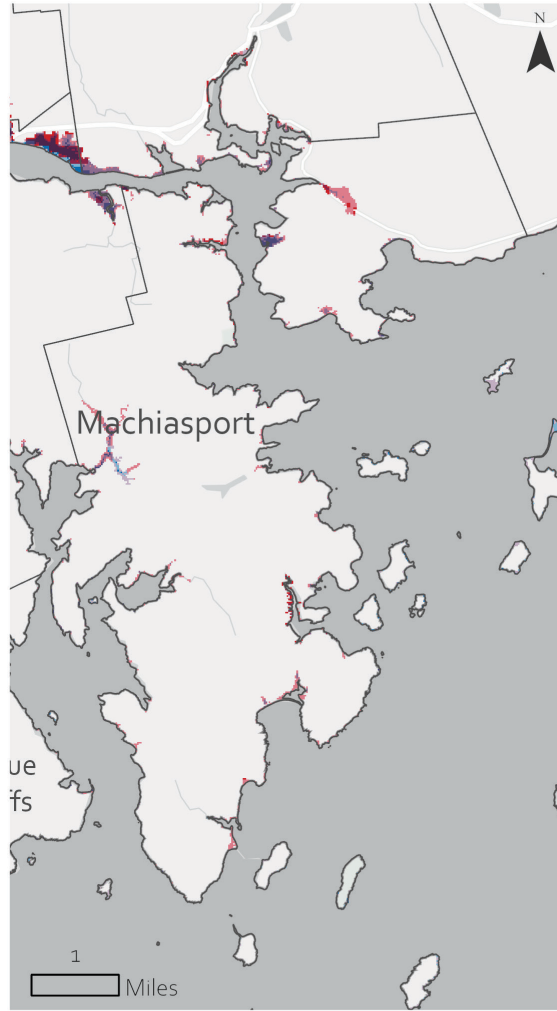


Population density and storm surge hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher storm surge hazard is in deep blue. Areas without storm surge values are not shown.

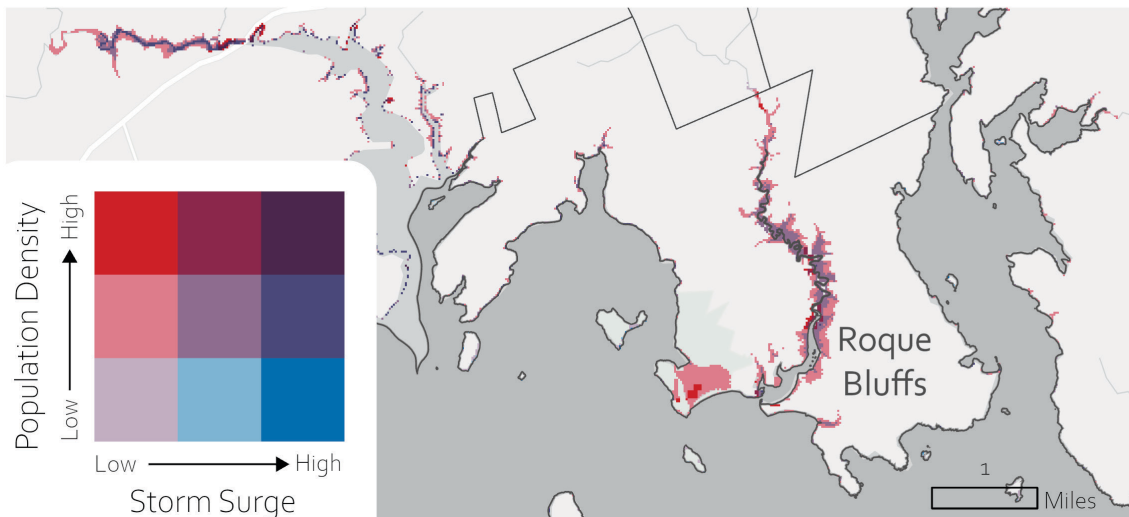
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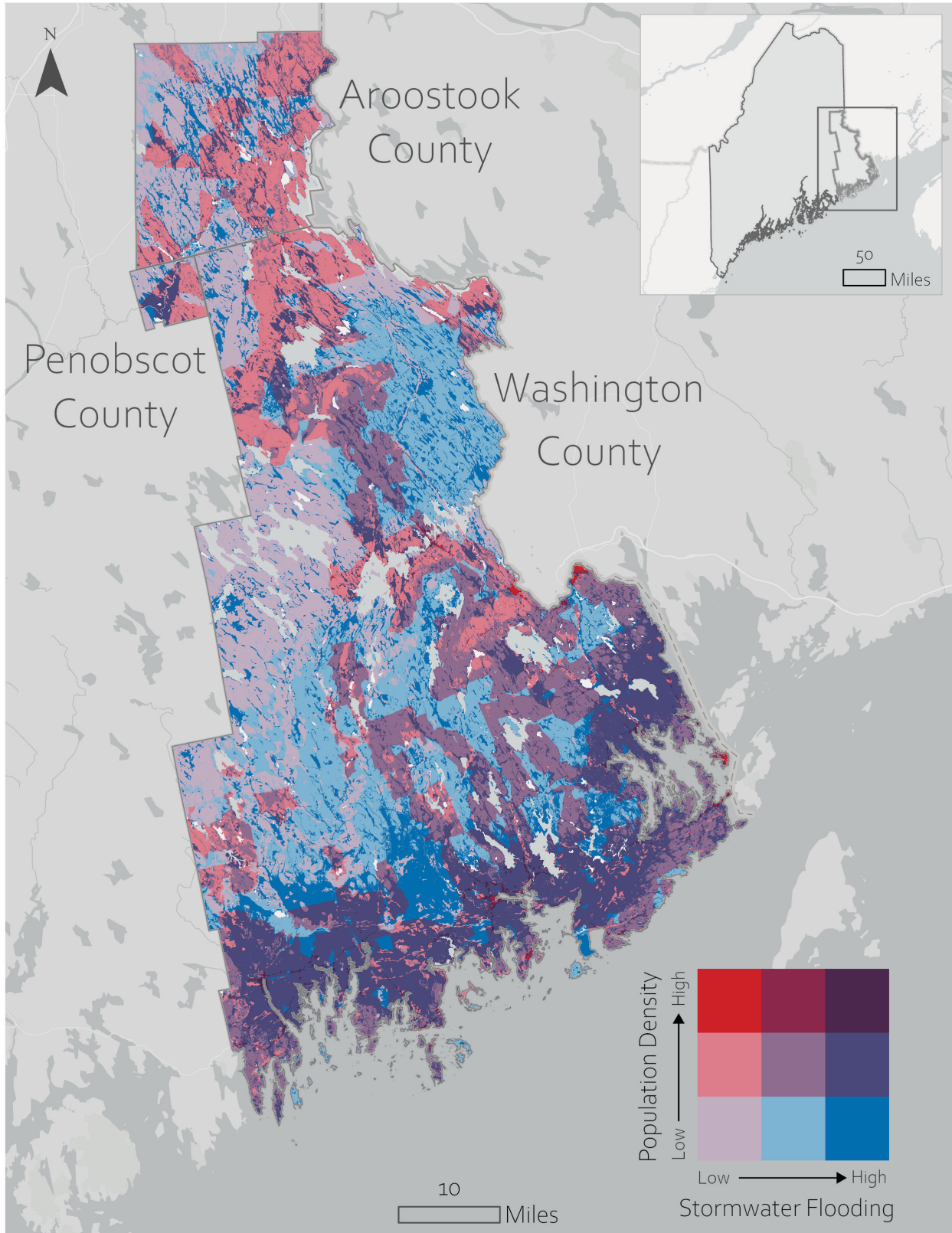


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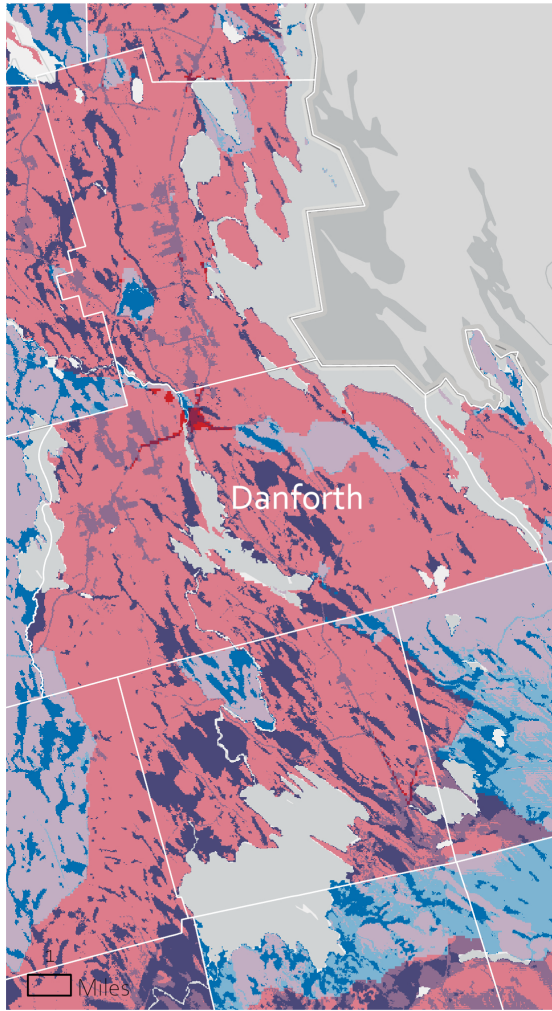
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Population density and storm surge hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher storm surge hazard is in deep blue. Areas without storm surge values are not shown.

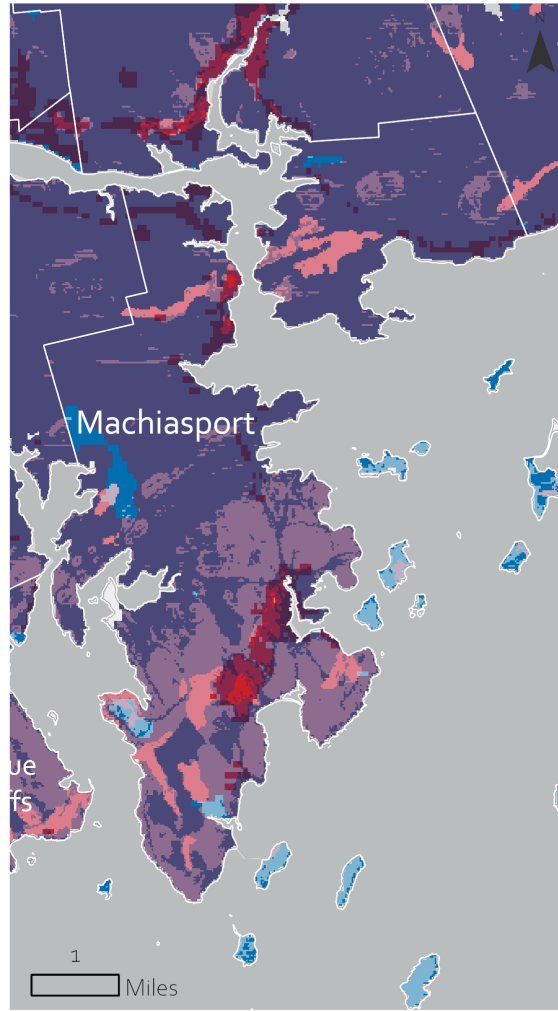


Population density and stormwater flooding hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher stormwater flood hazard is in deep blue.

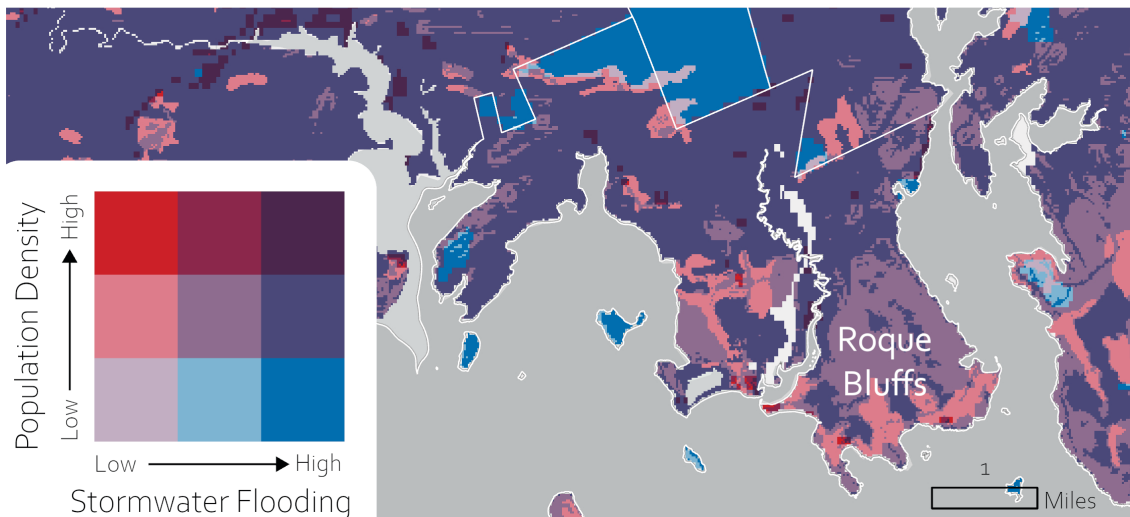
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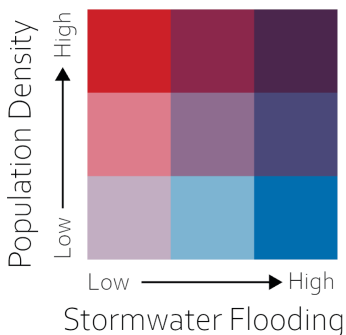
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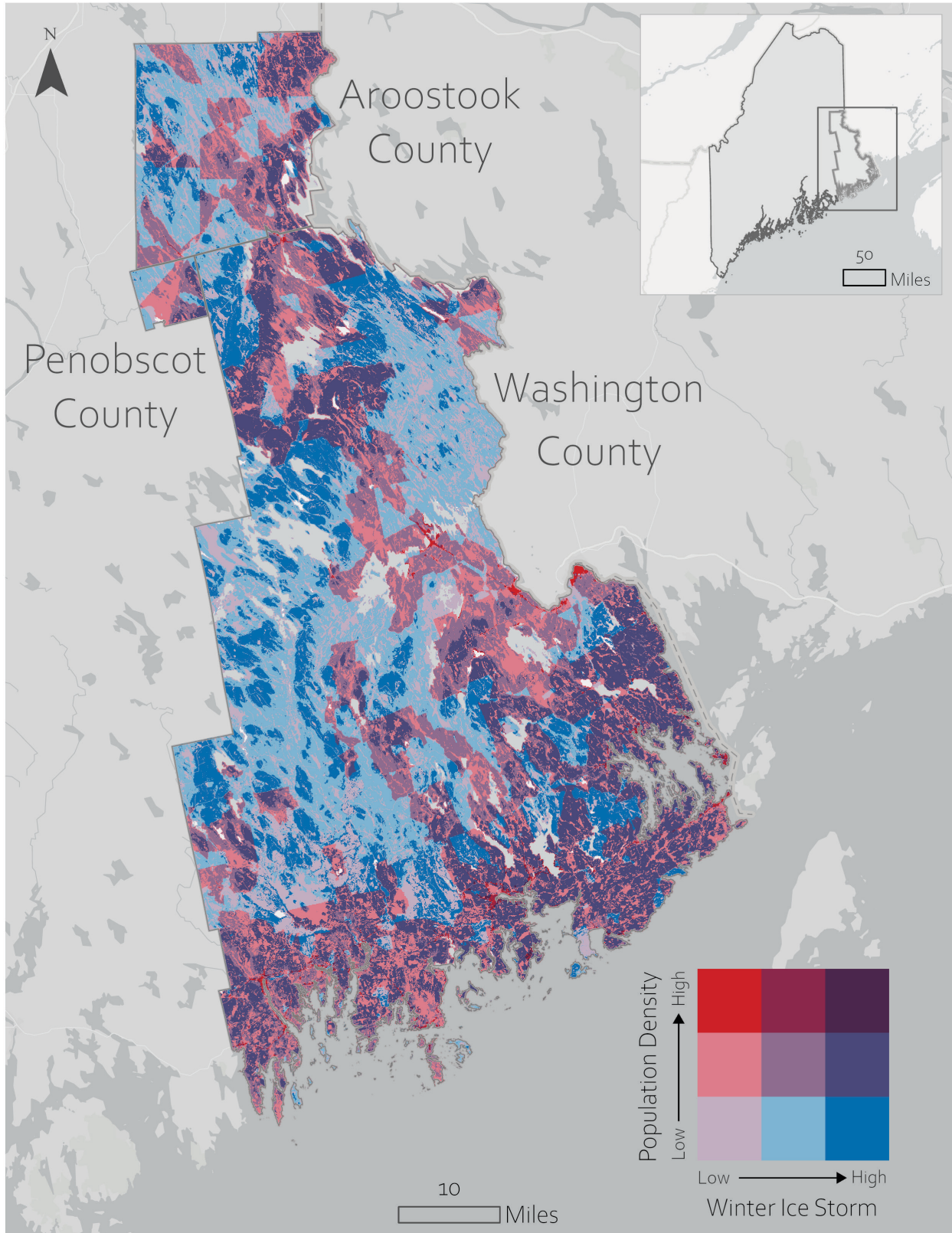
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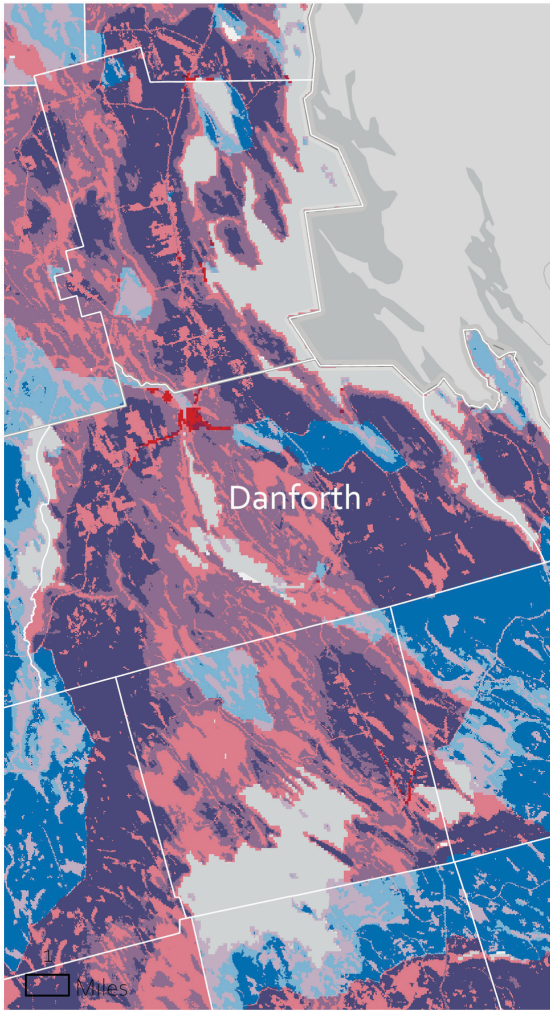


Population density and stormwater flooding hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher stormwater flood hazard is in deep blue.

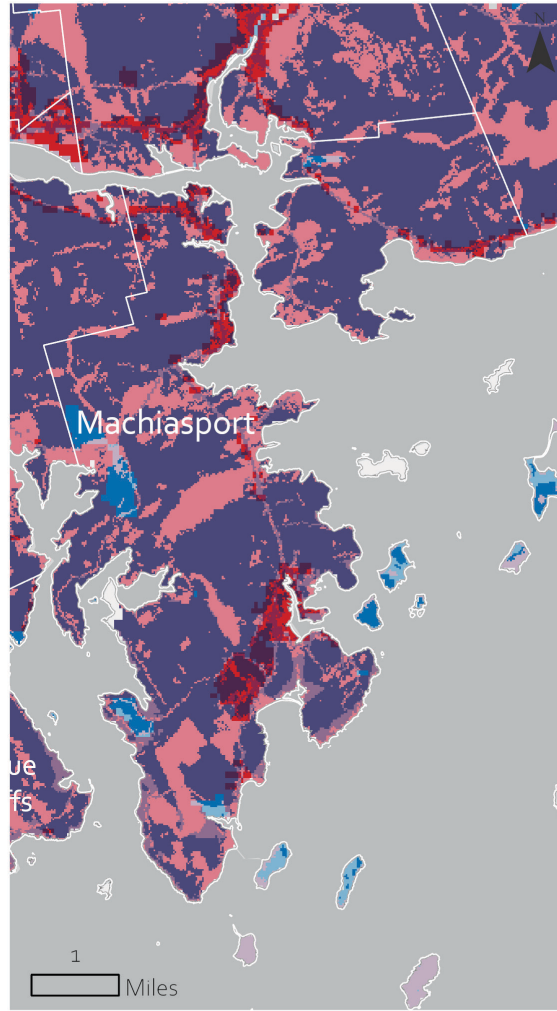


Population density and winter ice storm hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher winter ice storm hazard is in deep blue.

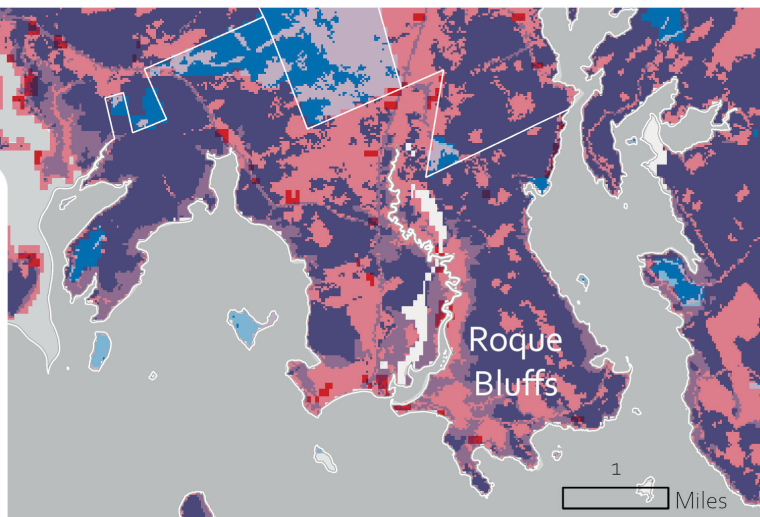
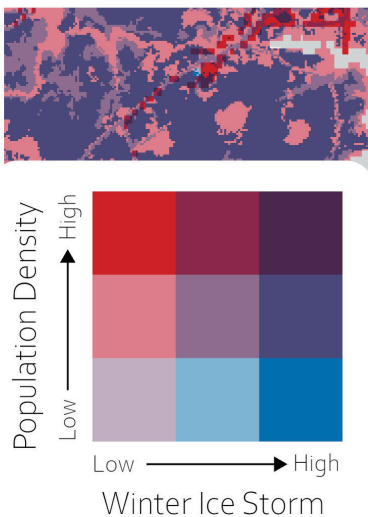
DANFORTH



MACHIASPORT

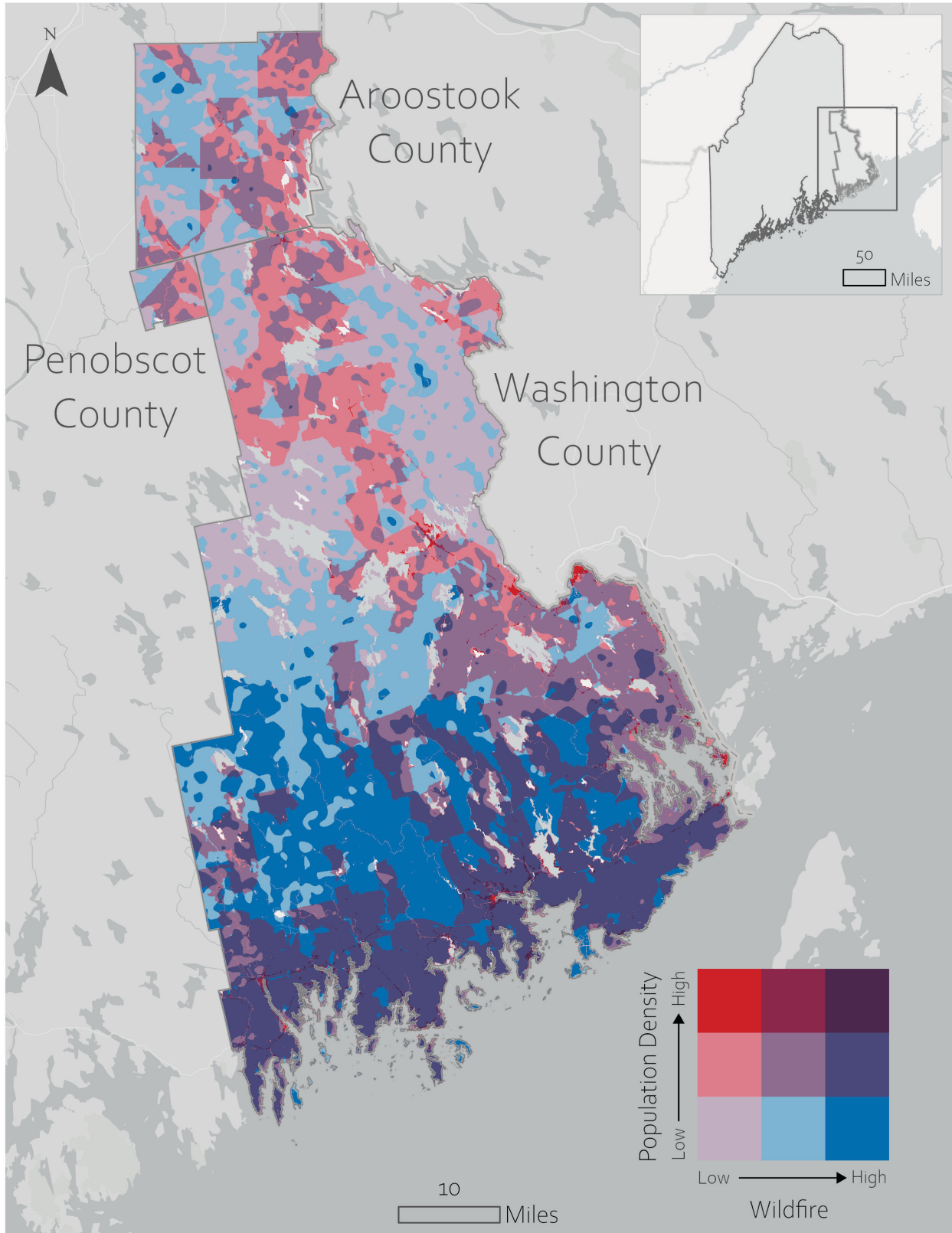


ROQUE BLUFFS



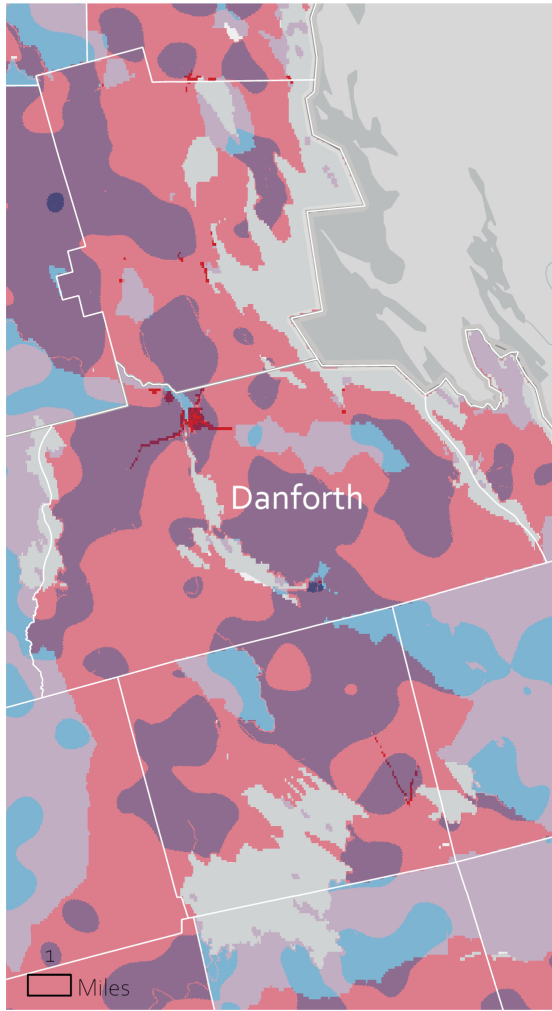
ROQUE BLUFFS

Population density and winter ice storm hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher winter ice storm hazard is in deep blue.

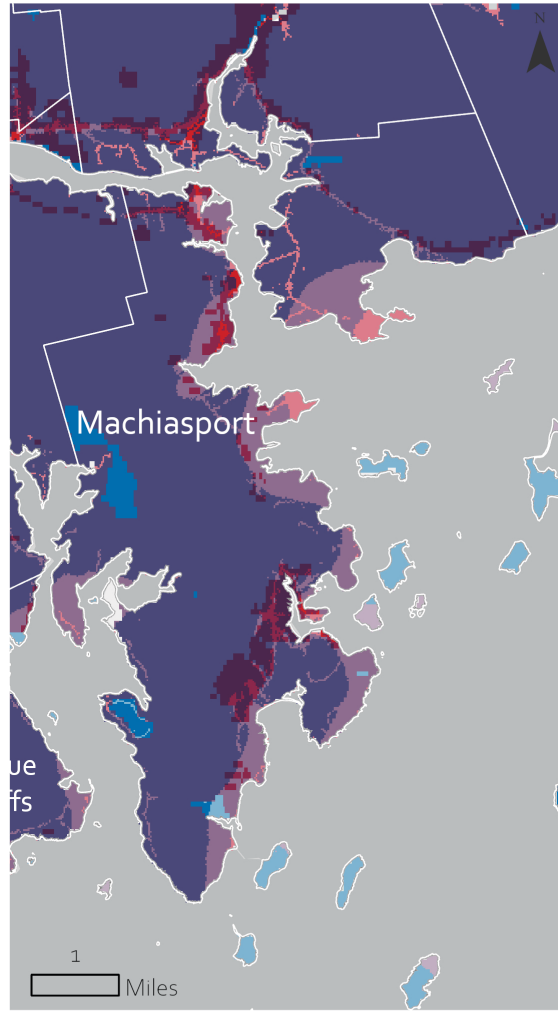


Population density and wildfire hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher wildfire hazard is in deep blue.

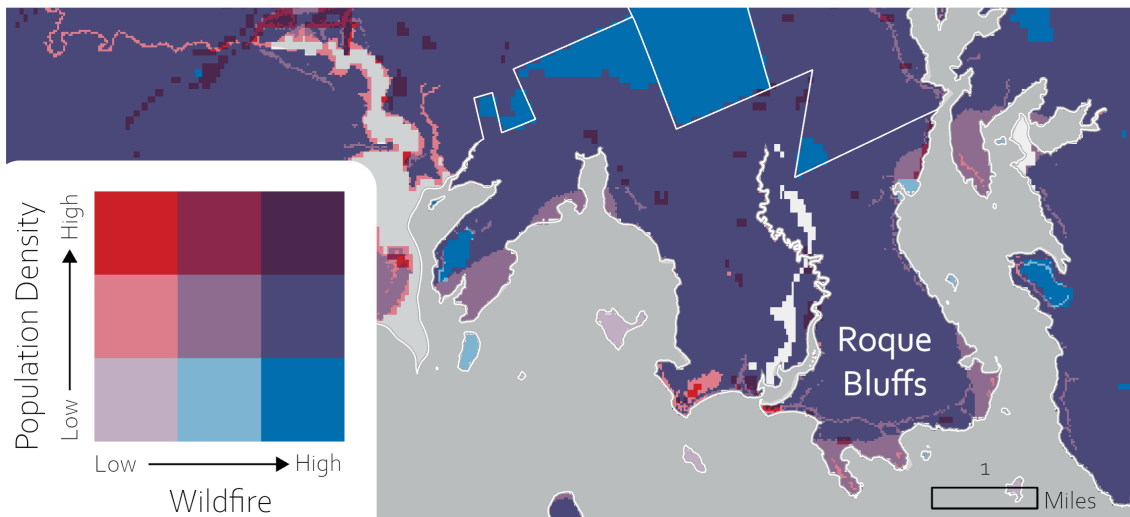
DANFORTH



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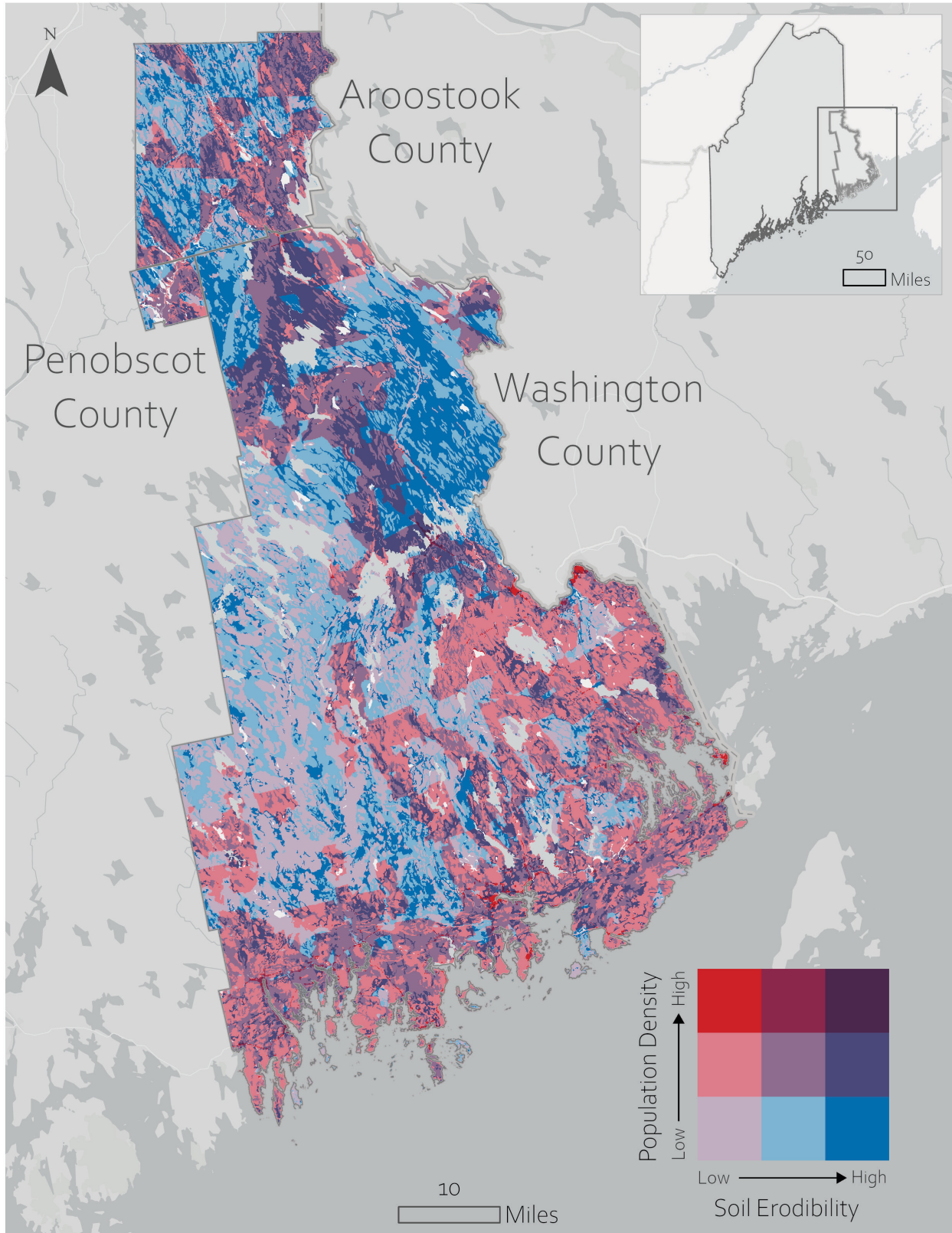


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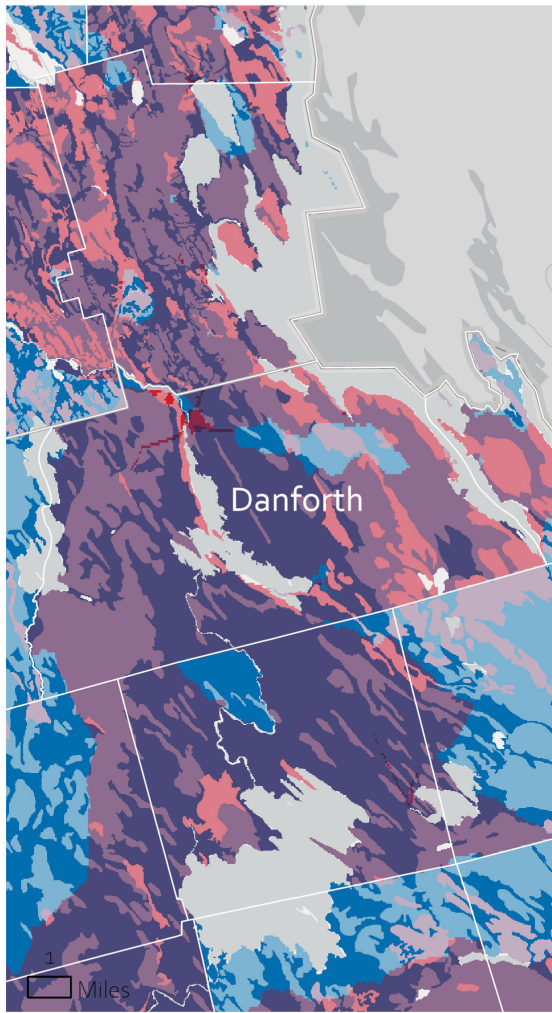
ROQUE BLUFFS

Population density and wildfire hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher wildfire hazard is in deep blue.

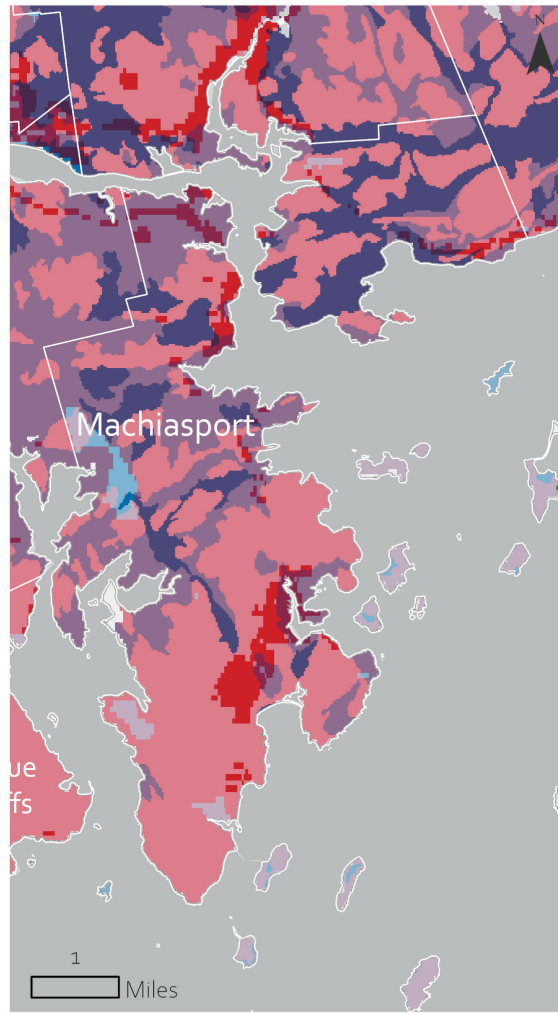


Population density and soil erodibility hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher soil erodibility is in deep blue.

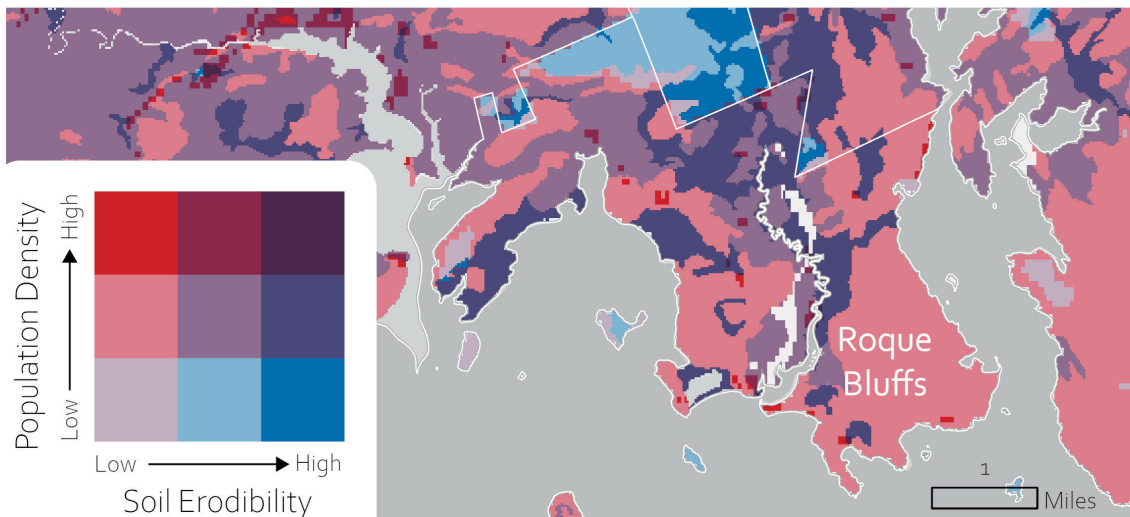
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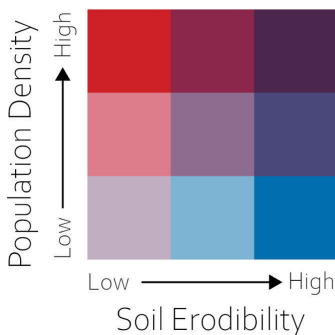
MACHIASPORT



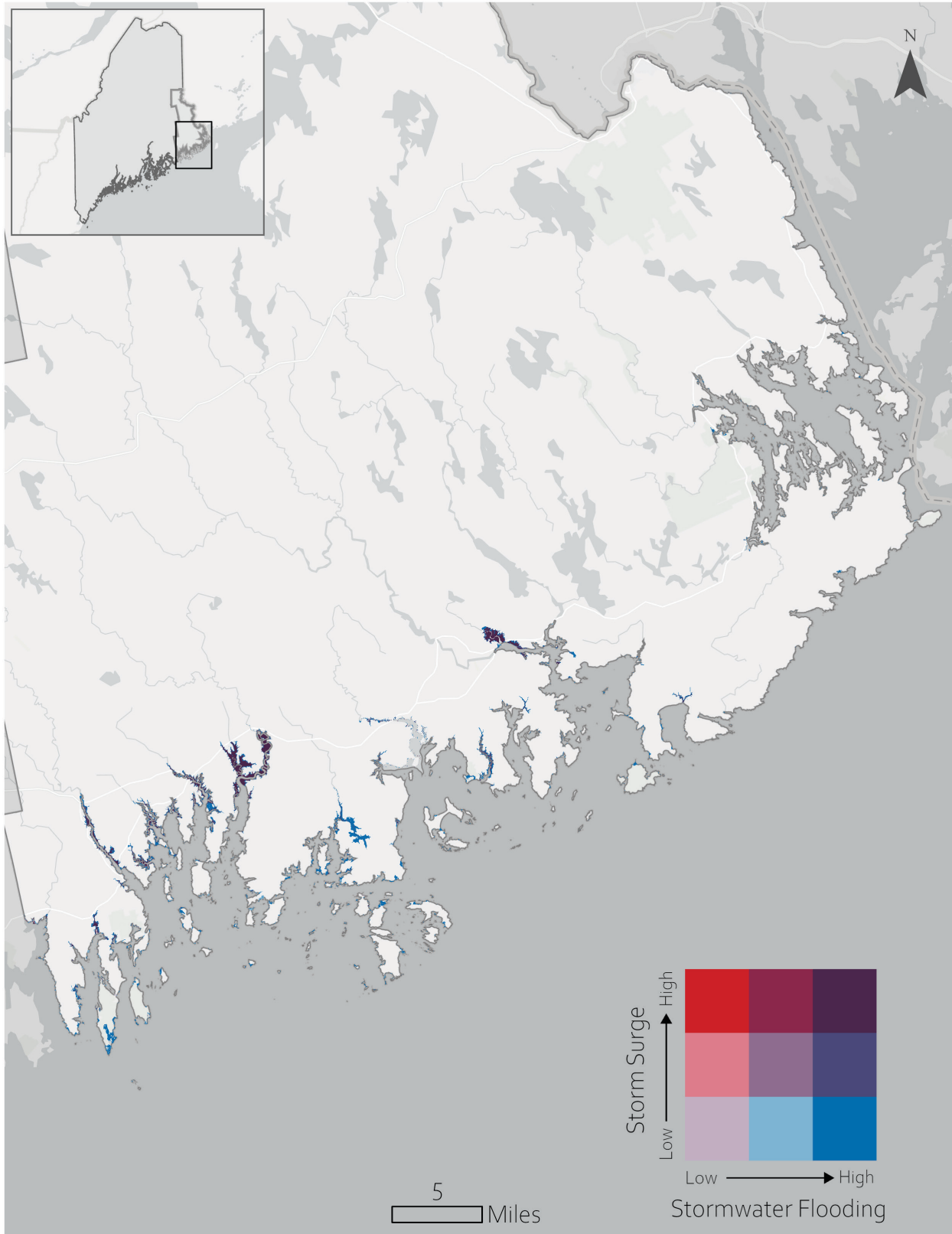
ROQUE BLUFFS



ROQUE BLUFFS



Population density and soil erodibility hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher population density is in crimson red, while higher soil erodibility is in deep blue.

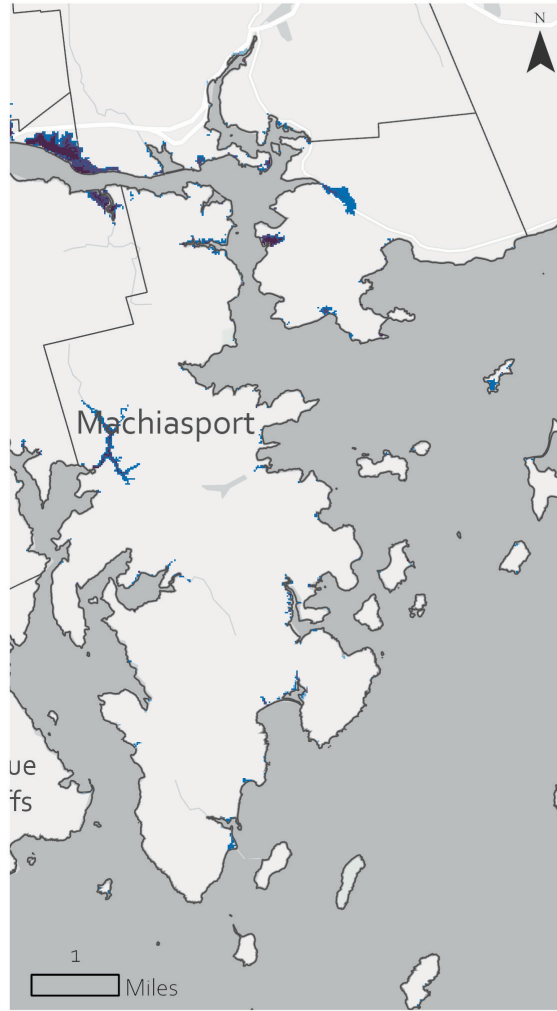


Storm surge hazard and stormwater flooding hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher storm surge hazard is in crimson red, while higher stormwater flood hazard is in deep blue. Areas without storm surge values are not shown.

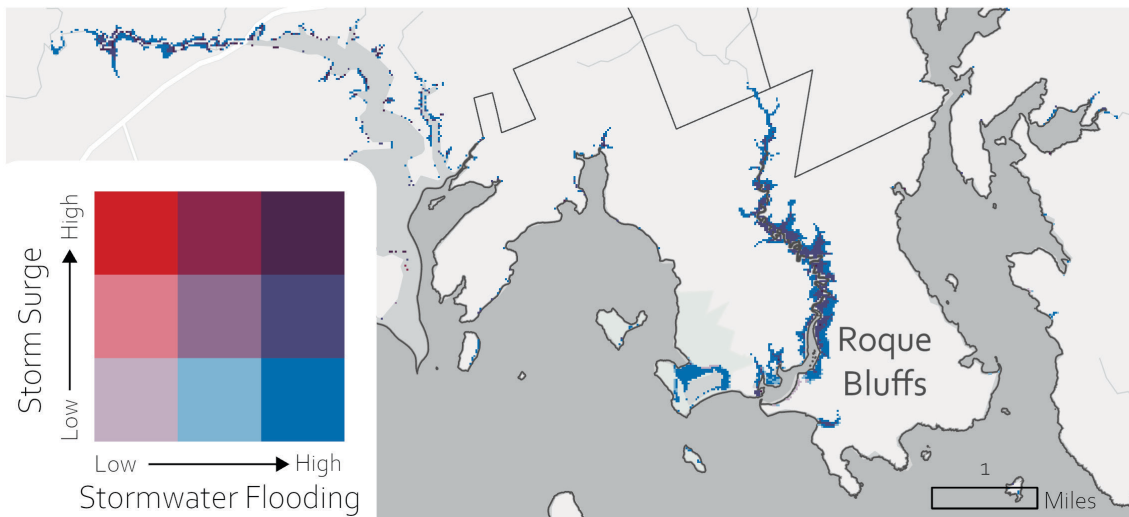
DANFORTH



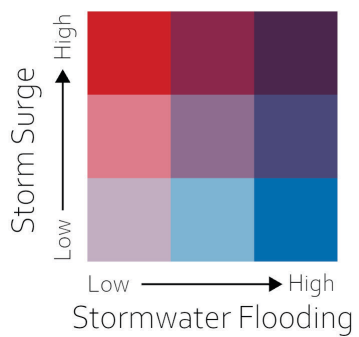
MACHIASPORT



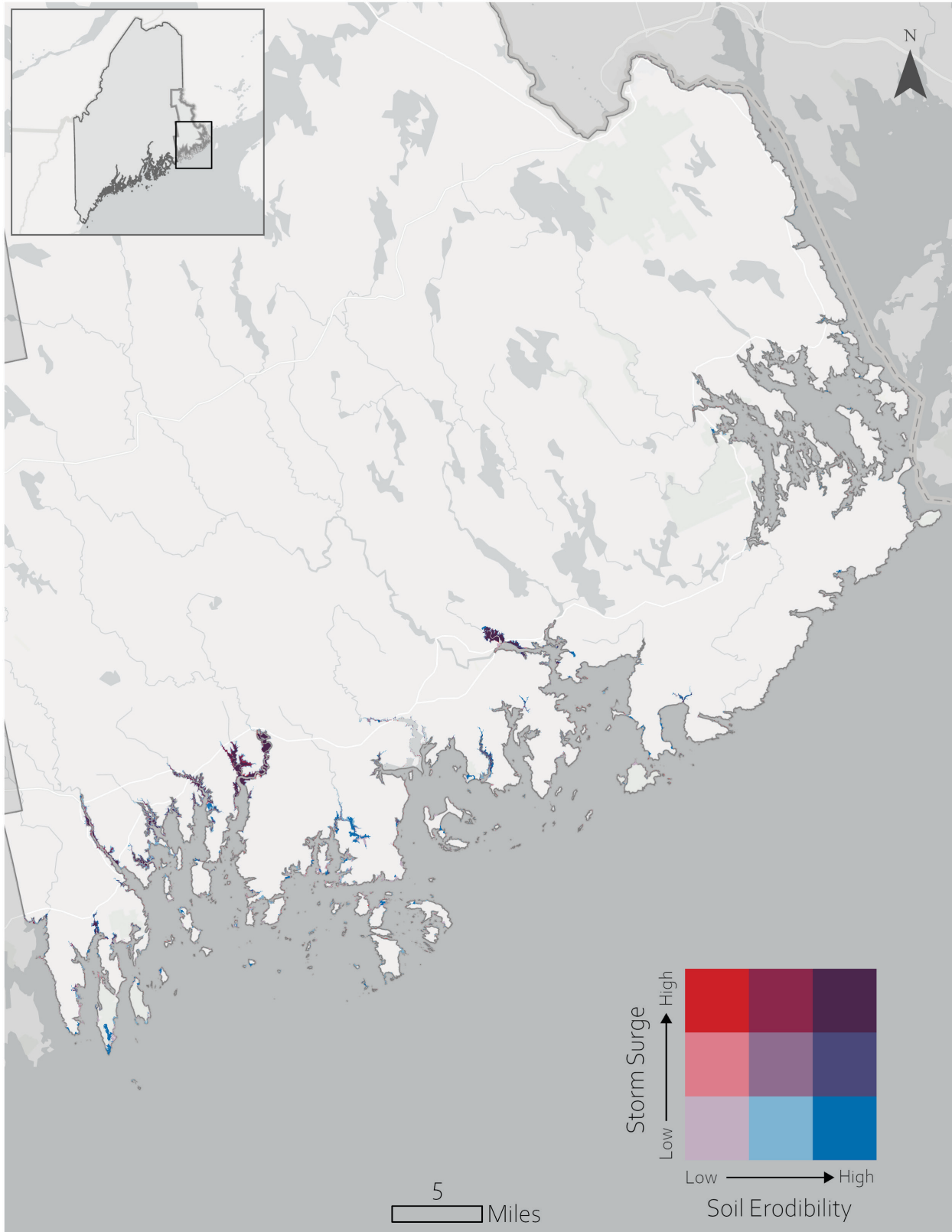
ROQUE BLUFFS



ROQUE BLUFFS



Storm surge hazard and stormwater flooding hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher storm surge hazard is in crimson red, while higher stormwater flood hazard is in deep blue. Areas without storm surge values are not shown.

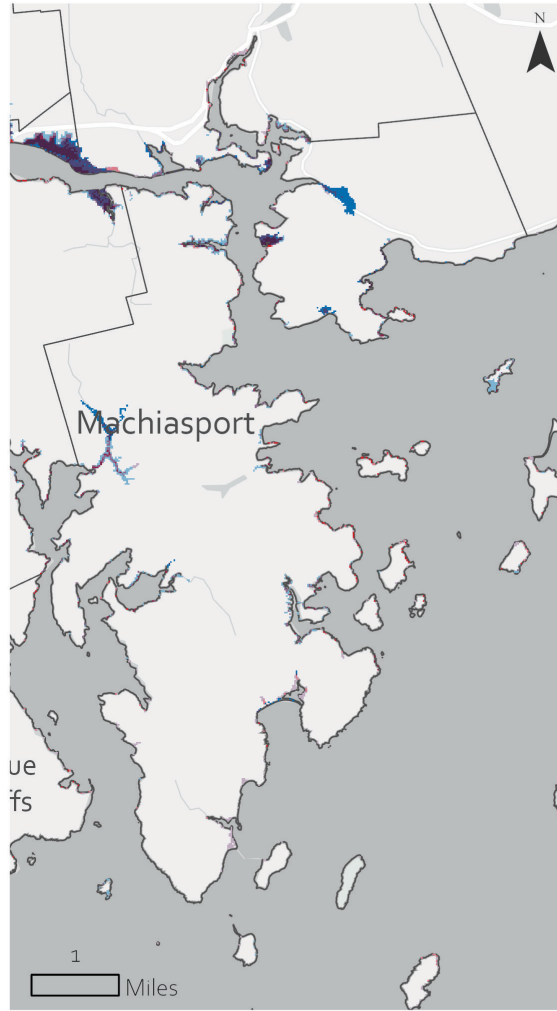


Storm surge hazard and soil erodibility hazard co-occurrence at 30-m resolution, with areas of highest co-occurrence shown in eggplant purple and areas of varying medium co-occurrence shown in maroon, medium purple, and violet. Higher storm surge hazard is in crimson red, while higher soil erodibility potential is in deep blue. Areas without storm surge values are not shown.

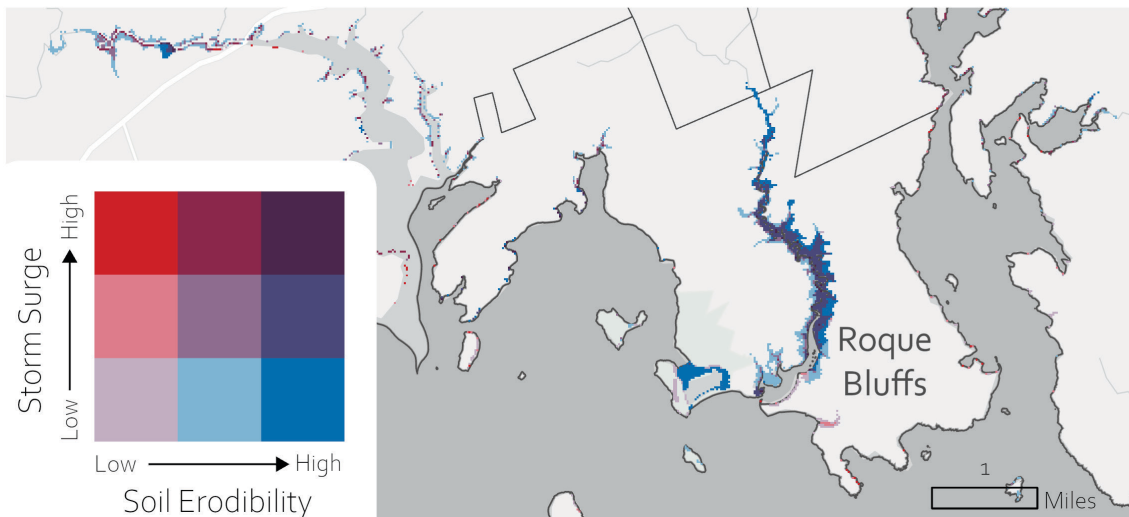
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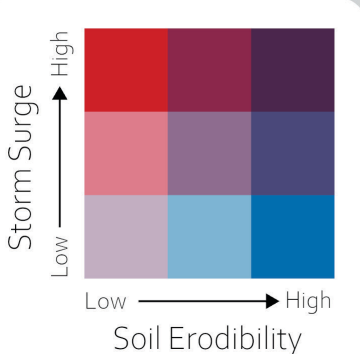
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ROQUE BLUFFS



ROQUE BLUFFS



Storm surge hazard and soil erodibility hazard co-occurrence at 30-m resolution, shown for Danforth, Machiasport, and Roque Bluffs. Areas of highest co-occurrence are shown in eggplant purple, and areas of varying medium co-occurrence are shown in maroon, medium purple, and violet. Higher storm surge hazard is in crimson red, while higher soil erodibility potential is in deep blue. Areas without storm surge values are not shown.

4 Road-Stream Crossing Risk

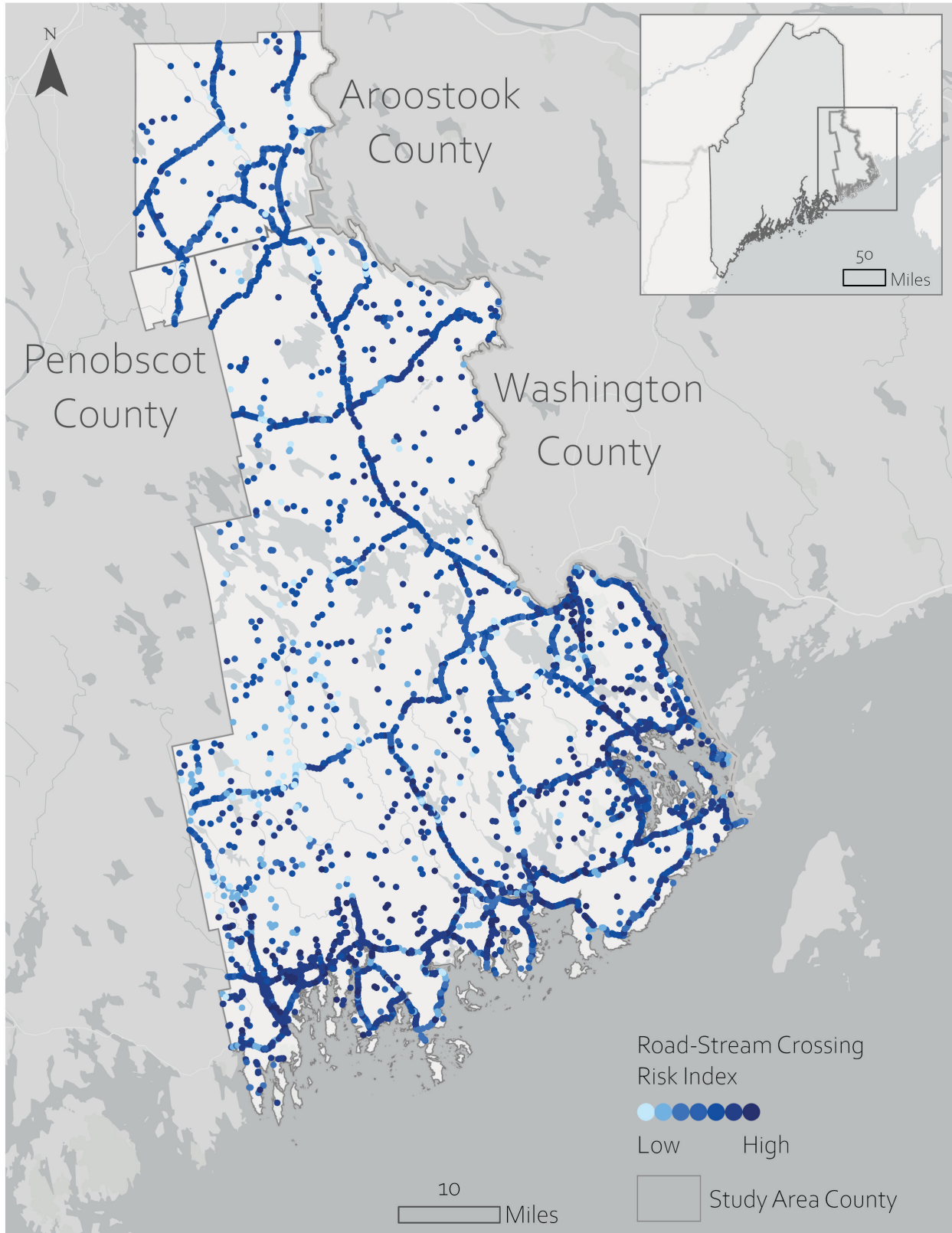
This section begins with the final road-stream crossing risk index, and then describes its development through 1) a comprehensive road-stream crossings dataset, 2) a soil erodibility index and indicators, and 3) a combined stormwater flooding and soil erodibility index.

Road-stream crossings included culverts and modeled roadway-waterway intersections to capture unmarked crossings. Soil erodibility potential incorporated infiltration, permeability, drainage, and wind erosion metrics. This was combined with precipitation-based stormwater flood hazard to estimate relative washout and damage potential from soil characteristics and flood likelihood (excluding culvert condition). All crossings were assigned risk values based on the combined soil hazard layer, and all map values are unitless index values relative to the study area.

This section enables decision makers to quickly **identify high-risk road-stream crossings, prioritize inspections, and guide maintenance planning**, including in locations where formal culvert data may be missing.



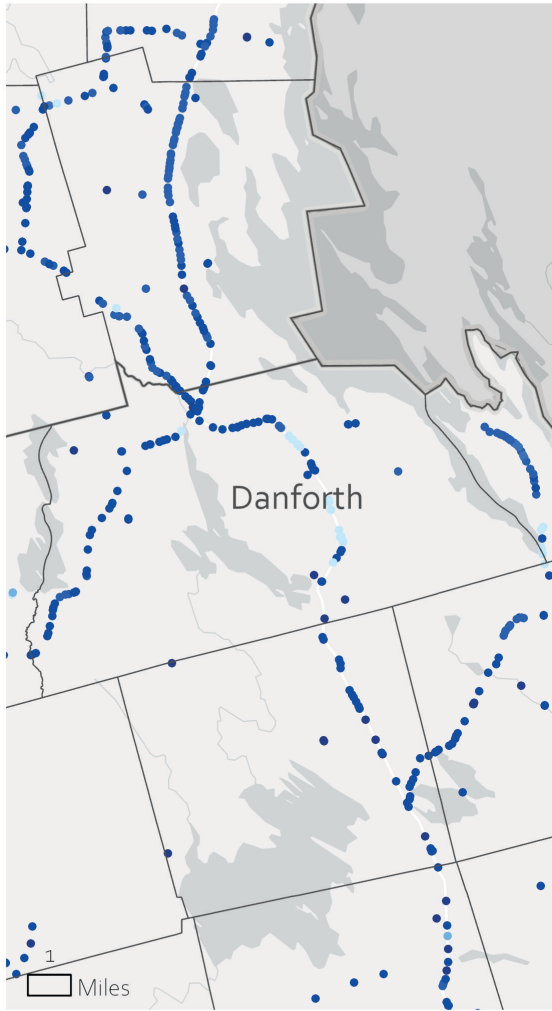
Evidence of asphalt erosion in Washington County with 5'8" model. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.



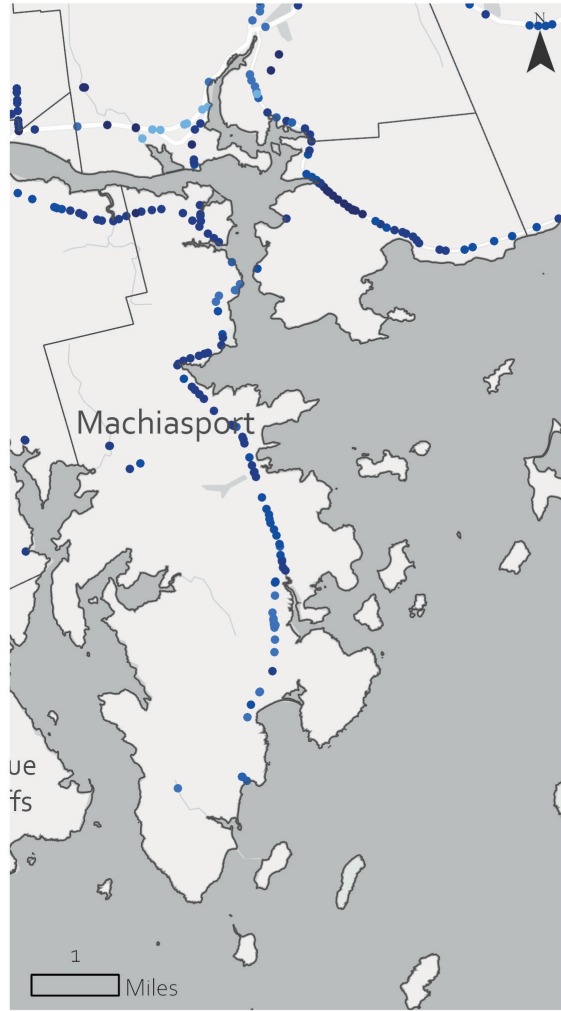
Road-stream crossing risk index* to assess relative risk of washout and impassable roads. All crossing points were assigned a corresponding risk value from the combined stormwater flooding and soil erodibility index. Higher risk is shown in darker blue, while lower risk is shown in lighter blue.

*Excluding coastal storm hazard.

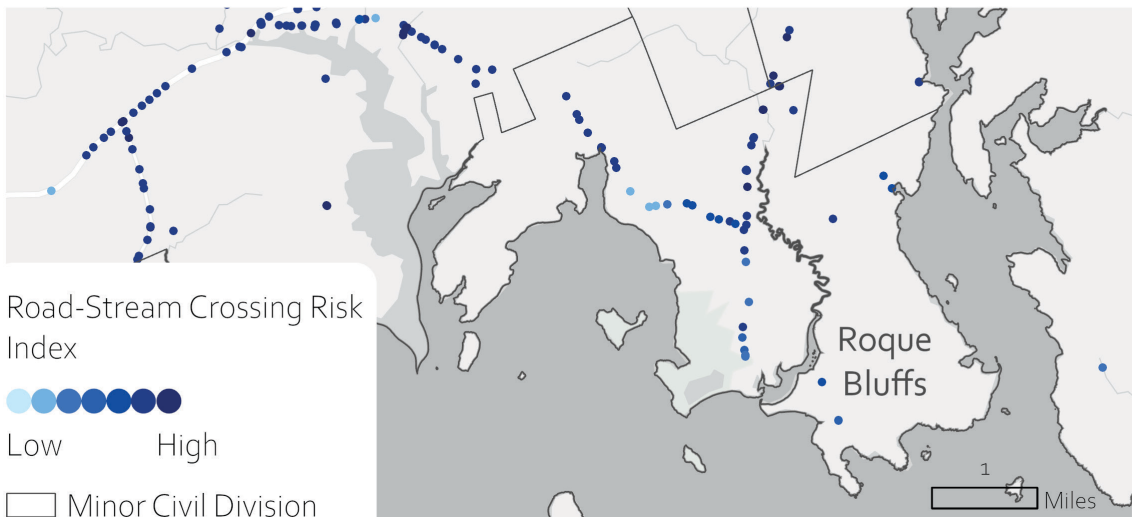
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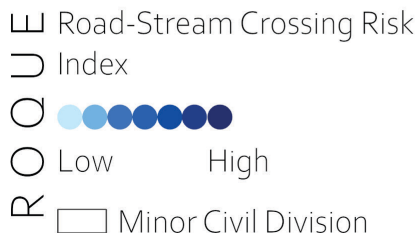
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ROQUE BLUFFS

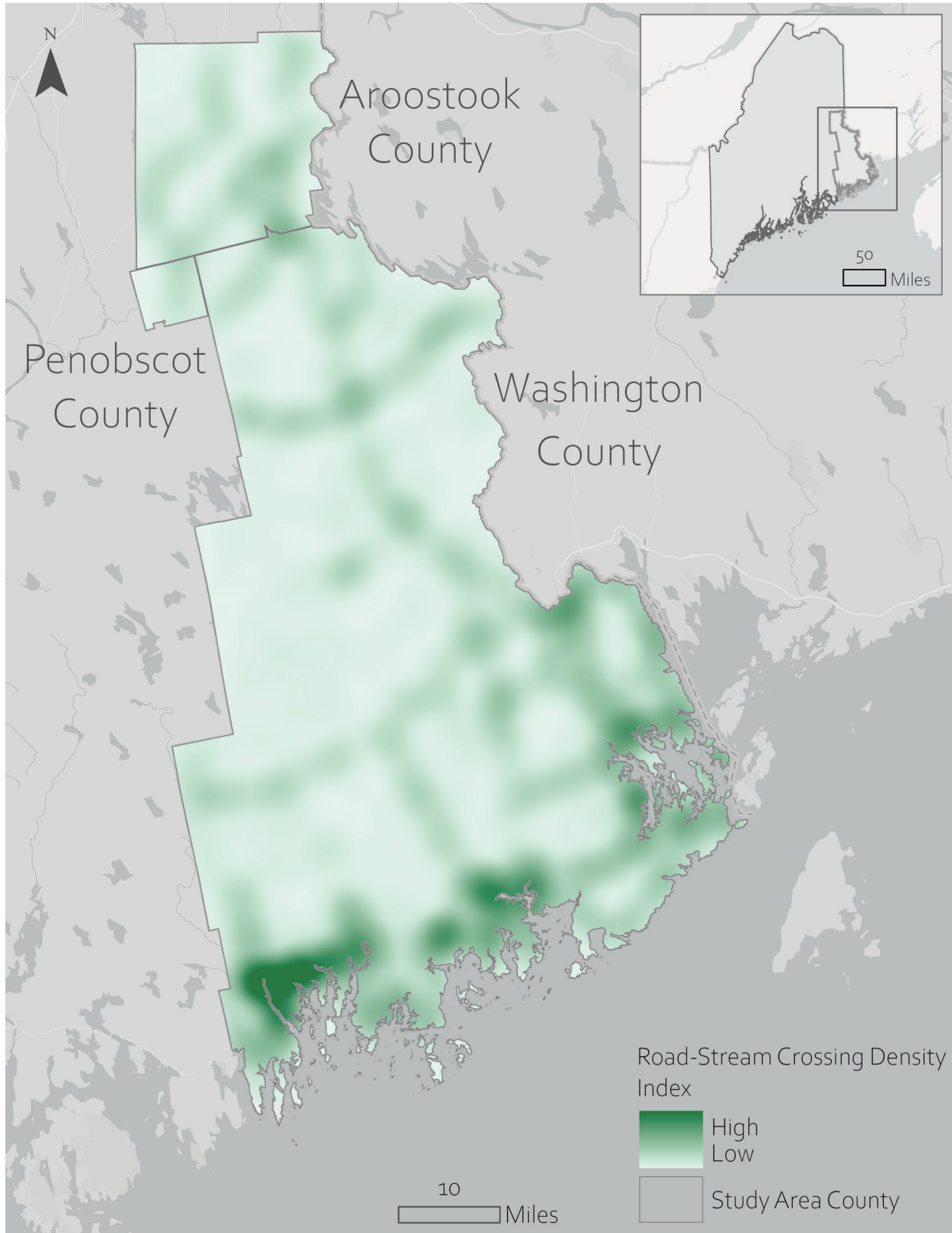


ROQUE BLUFFS

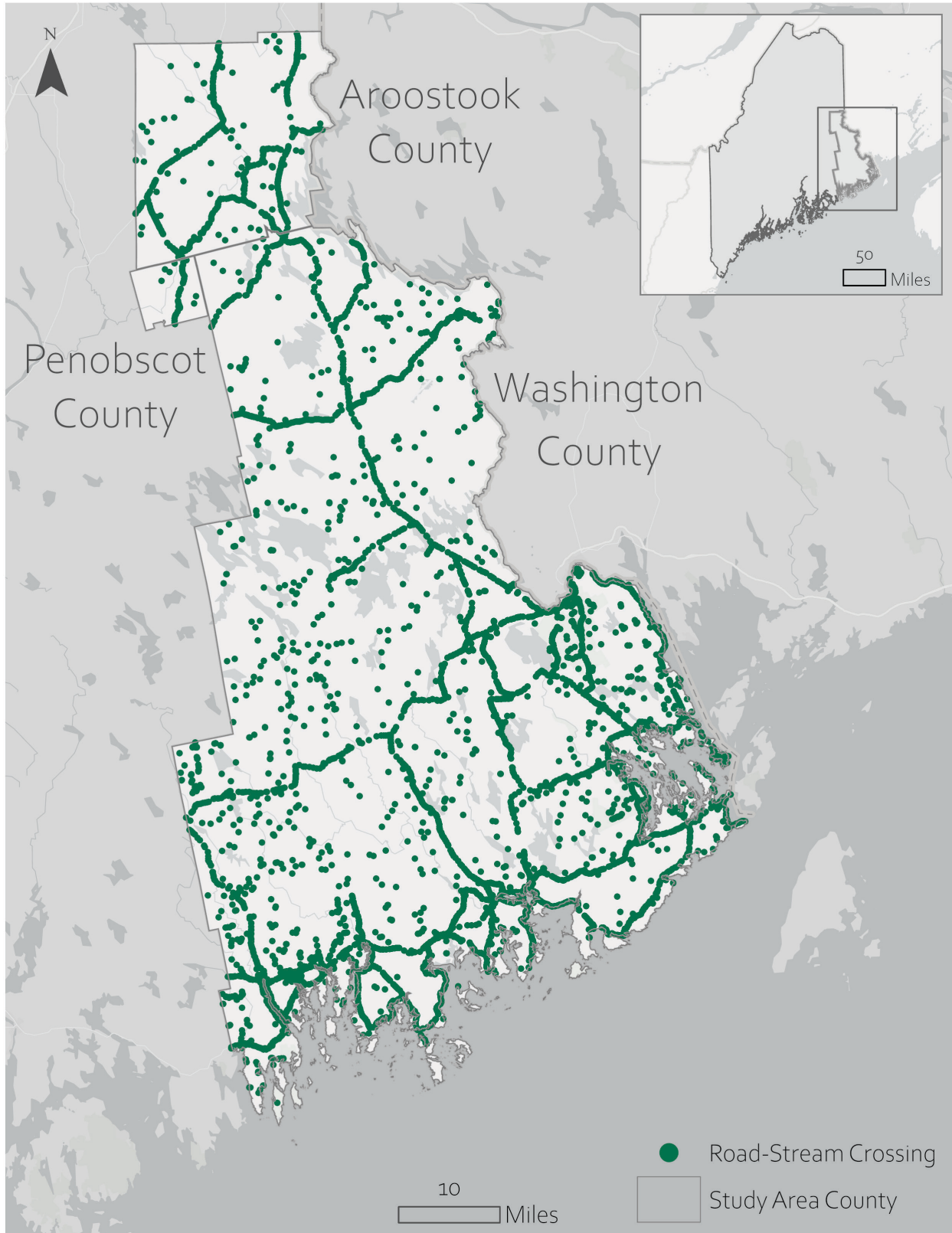


Road-stream crossing risk index* to assess relative risk of washout and impassable roads, shown for Danforth, Machiasport, and Roque Bluffs. Higher risk is shown in darker blue, while lower risk is shown in lighter blue.

*Excluding coastal storm hazard.

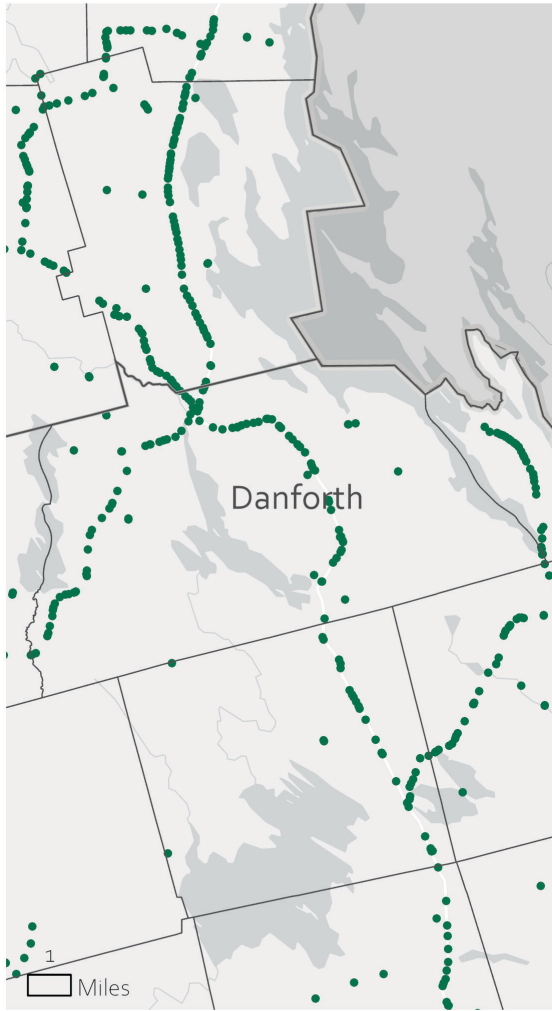


Road-stream crossing density index in 30-m resolution, developed from the comprehensive road-stream crossings dataset shown on the next two pages. Higher crossing density is shown in darker green, while lower crossing density is shown in lighter green.

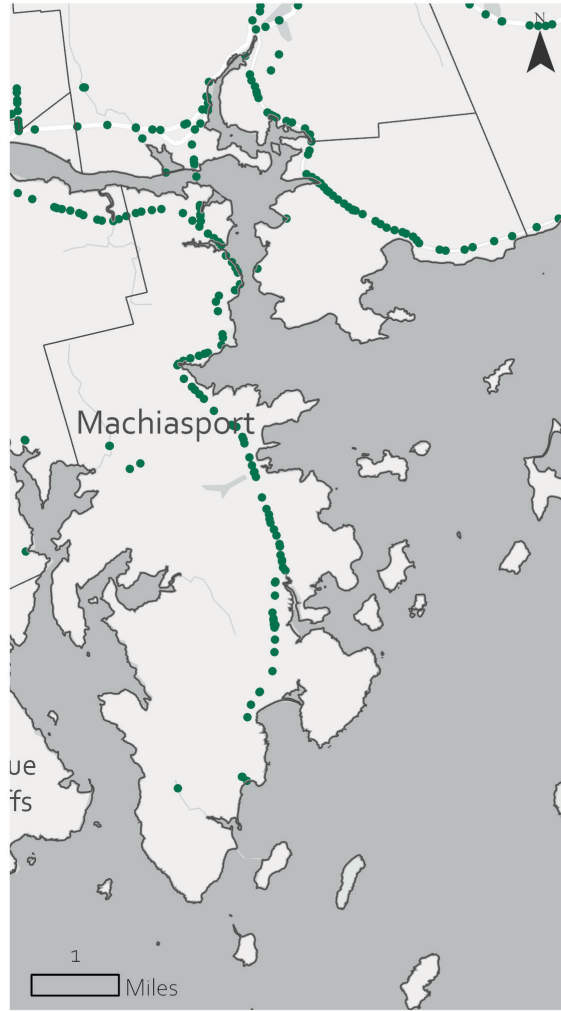


Comprehensive road-stream crossings dataset displaying intersections between roads and streams. Points include known culverts and crossings on public roads as well as modeled potential crossings across public, private, and industry roads.

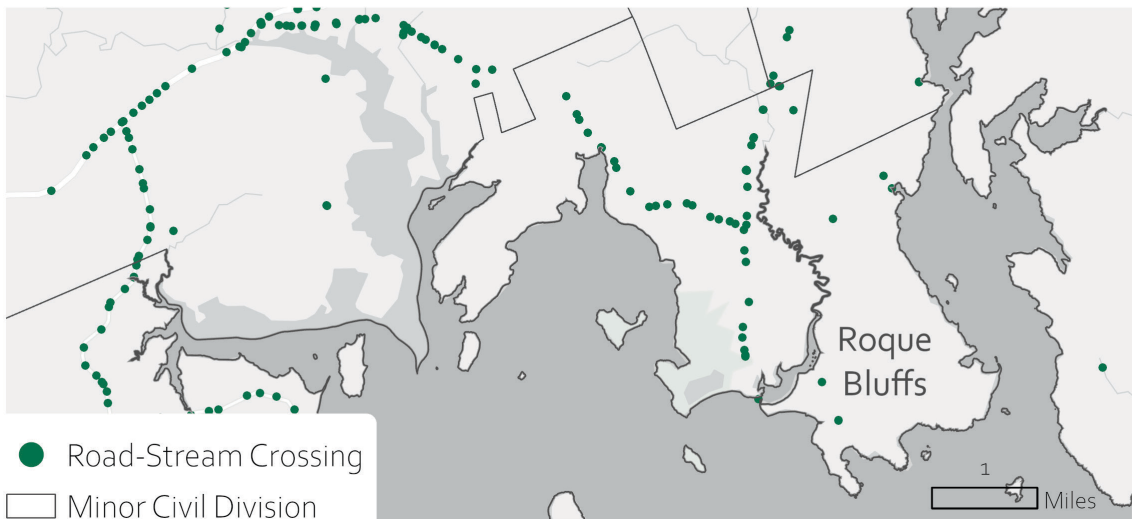
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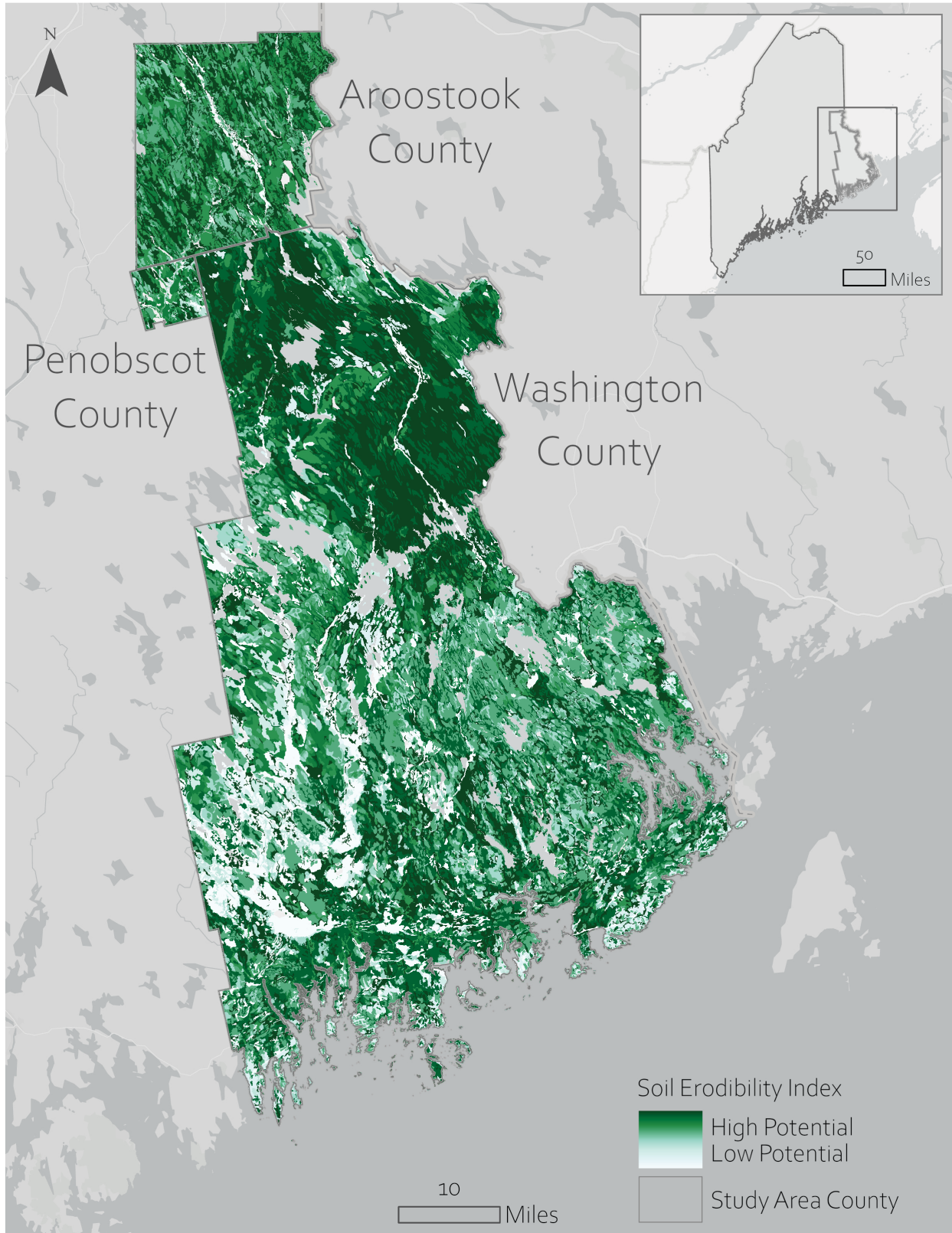
ROQUE BLUFFS



ROQUE BLUFFS

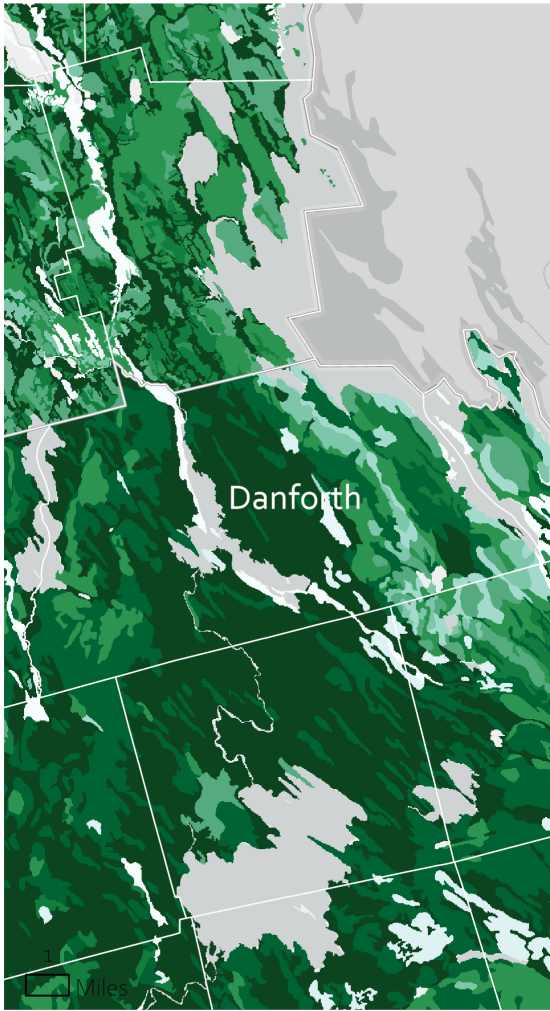
- Road-Stream Crossing
- Minor Civil Division

Comprehensive road-stream crossings dataset shown for Danforth, Machiasport, and Roque Bluffs. Points include known culverts and crossings on public roads as well as modeled potential crossings across public, private, and industry roads.

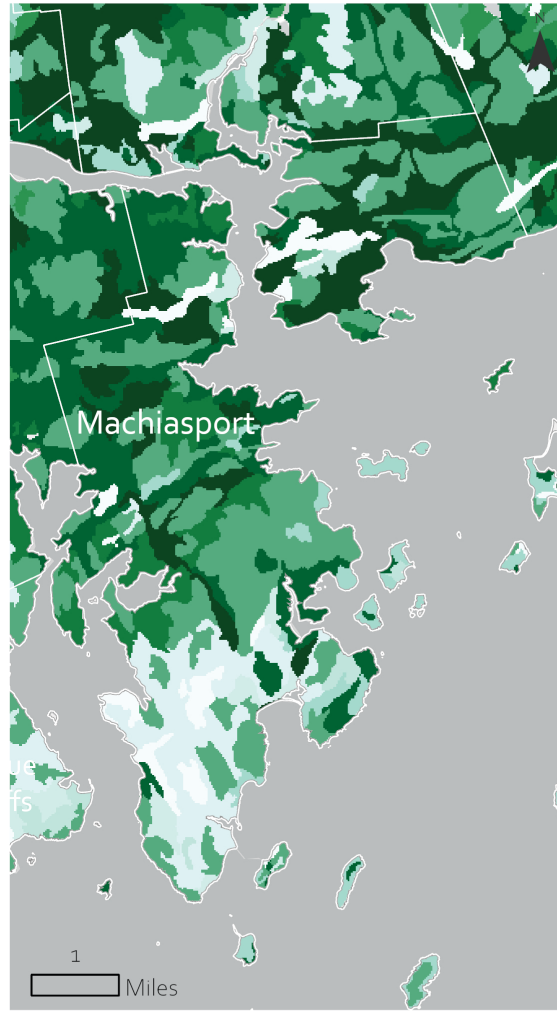


Soil erodibility index at 30-m resolution, created by combining three indicators: hydrologic soil group, drainage class, and wind erodibility. Higher soil erodibility potential is shown in darker green, while lower soil erodibility potential is shown in lighter green and white.

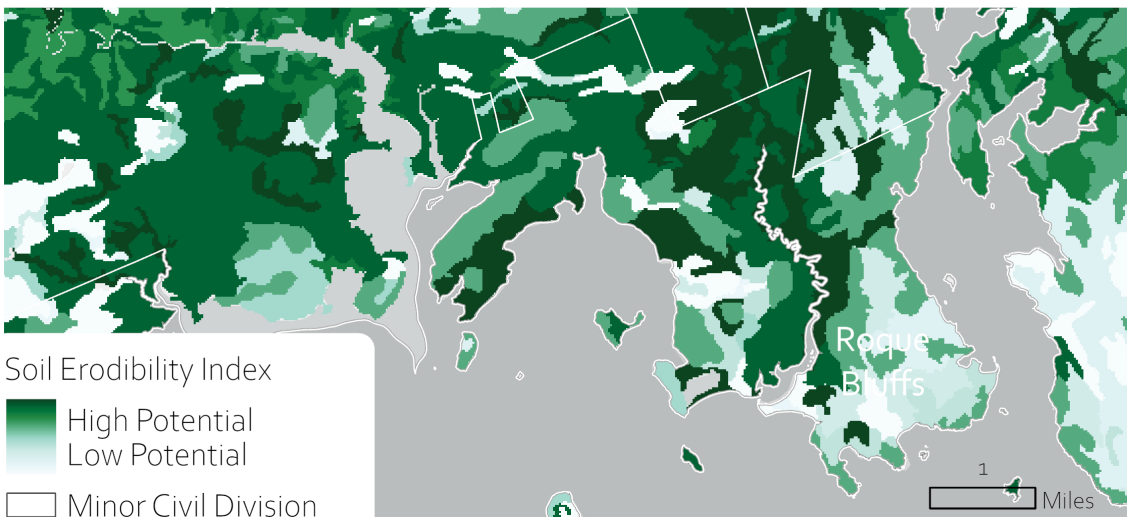
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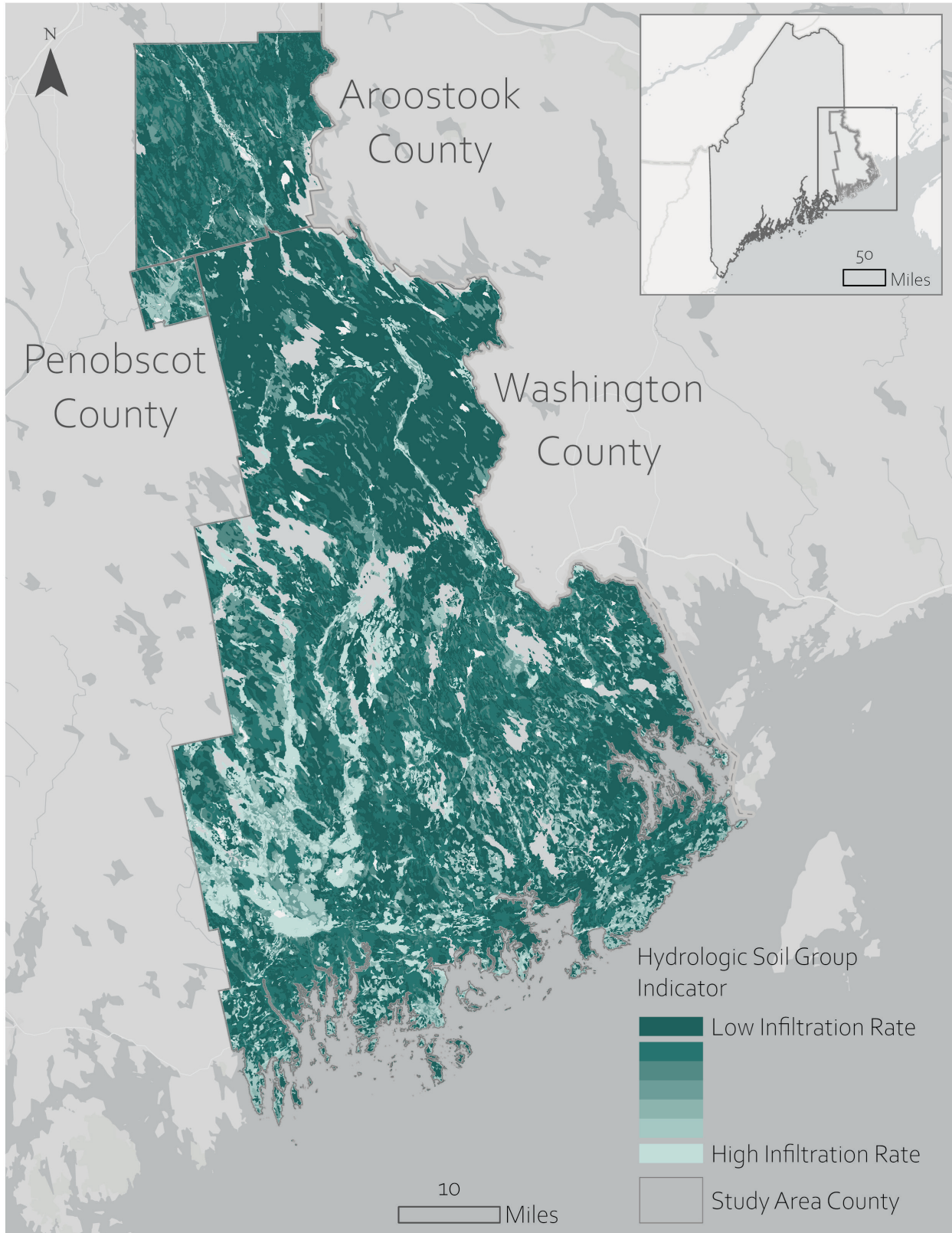


ROQUE BLUFFS

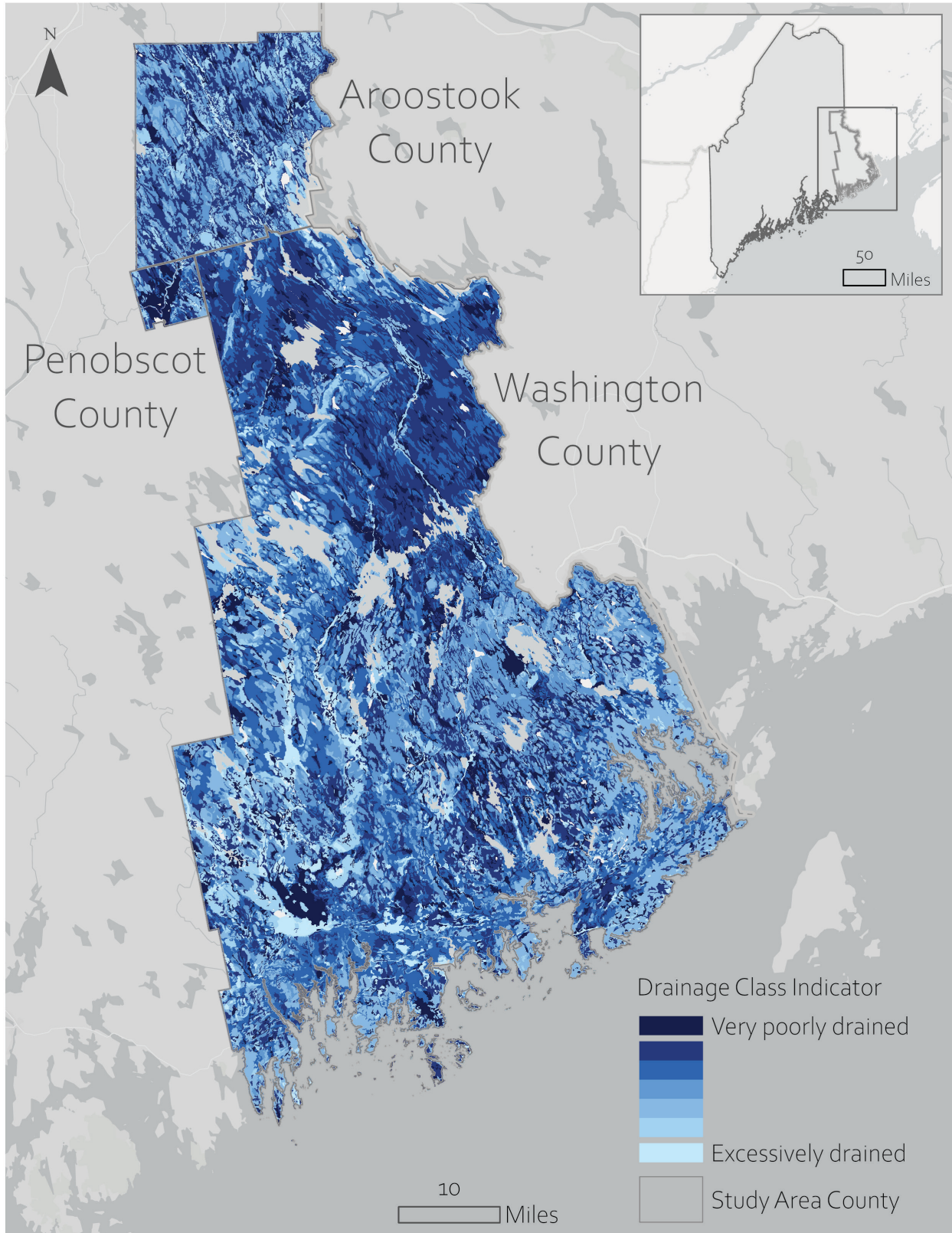
Soil Erodibility Index

- High Potential
- Low Potential
- Minor Civil Division

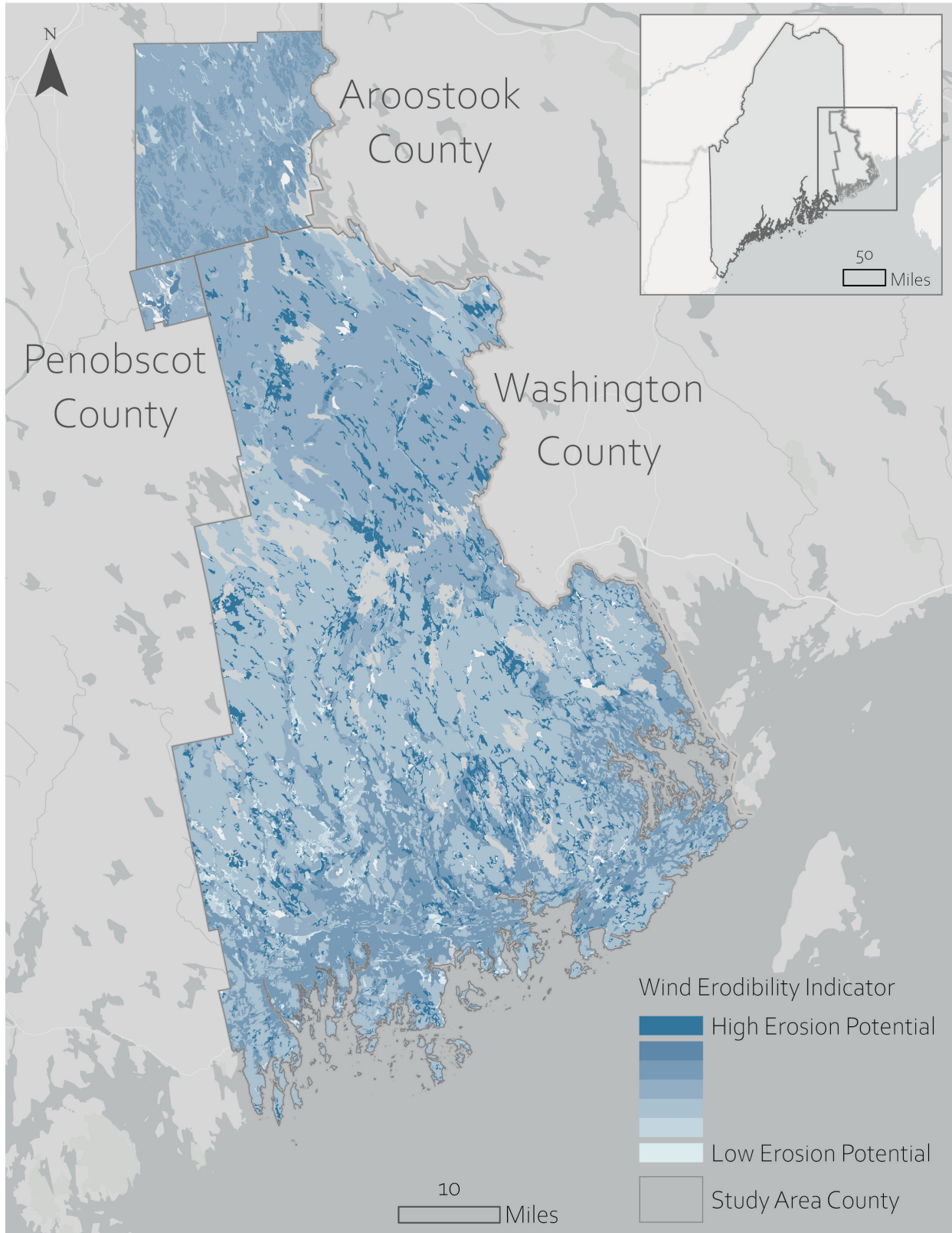
Soil erodibility index at 30-m resolution shown for Danforth, Machiasport, and Roque Bluffs. Higher soil erodibility potential is shown in darker green, while lower soil erodibility potential is shown in lighter green and white.



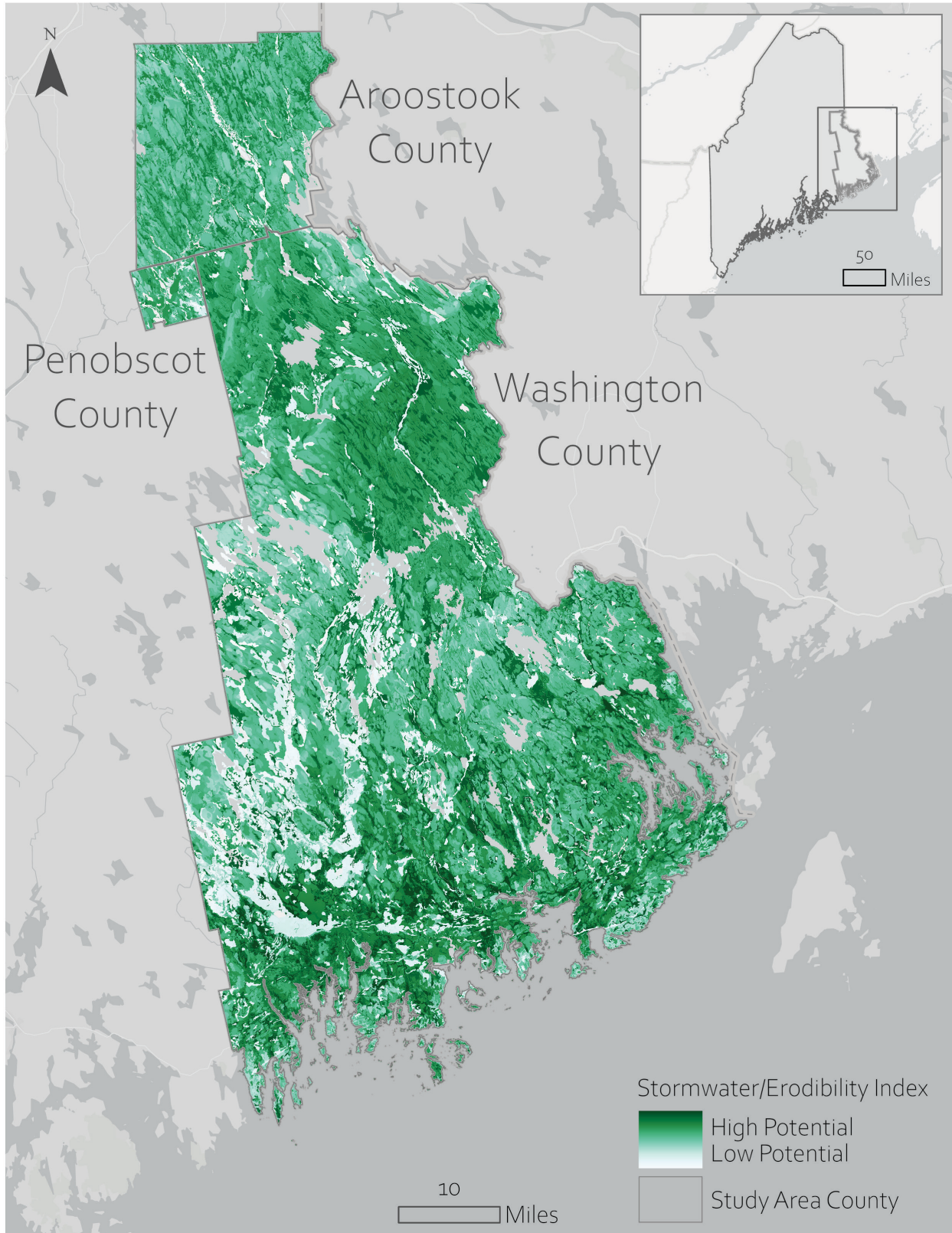
Hydrologic soil group indicator at 30-m resolution, reclassified by soil erodibility potential from lower infiltration rates in darker teal to higher infiltration rates in lighter teal. This indicator is the first of three indicators for this assessment's soil erodibility index.



Drainage class indicator at 30-m resolution, reclassified by soil erodibility potential from very poorly drained in darker blue to excessively drained in lighter blue. This indicator is the second of three indicators for this assessment’s soil erodibility index.



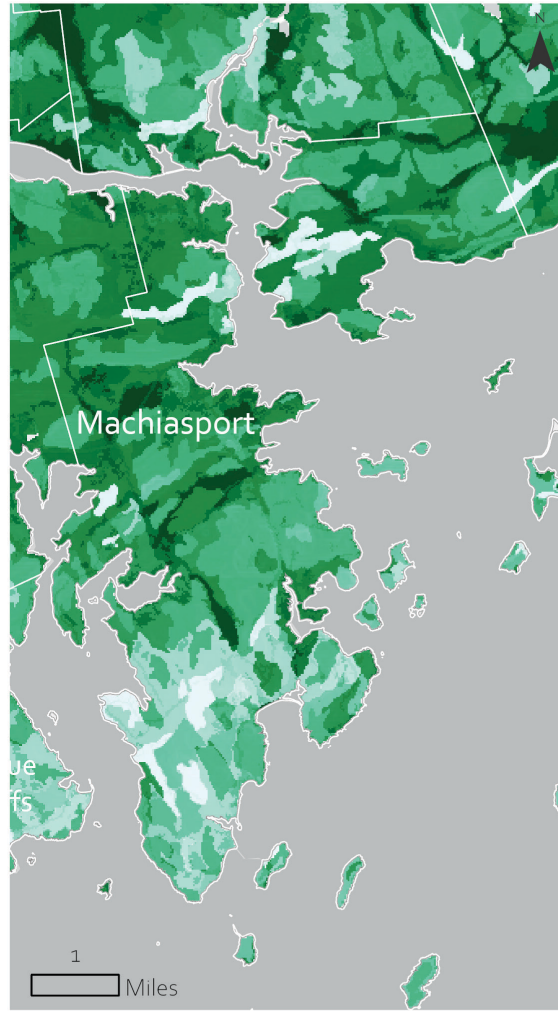
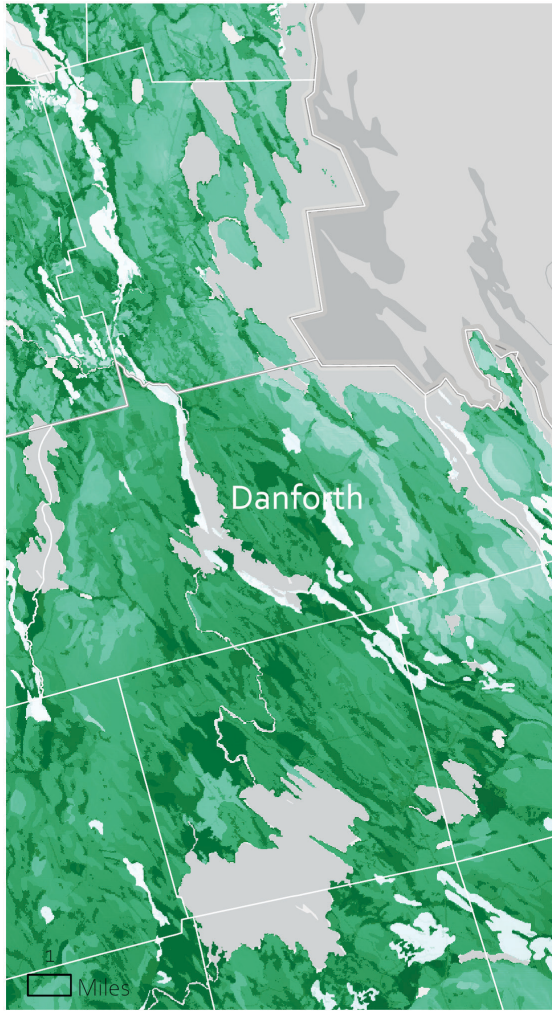
Wind erodibility group indicator at 30-m resolution, reclassified by soil erodibility potential from higher erosion potential in darker blue to lower erosion potential in lighter blue. This indicator is the third of three indicators for this assessment’s soil erodibility index.



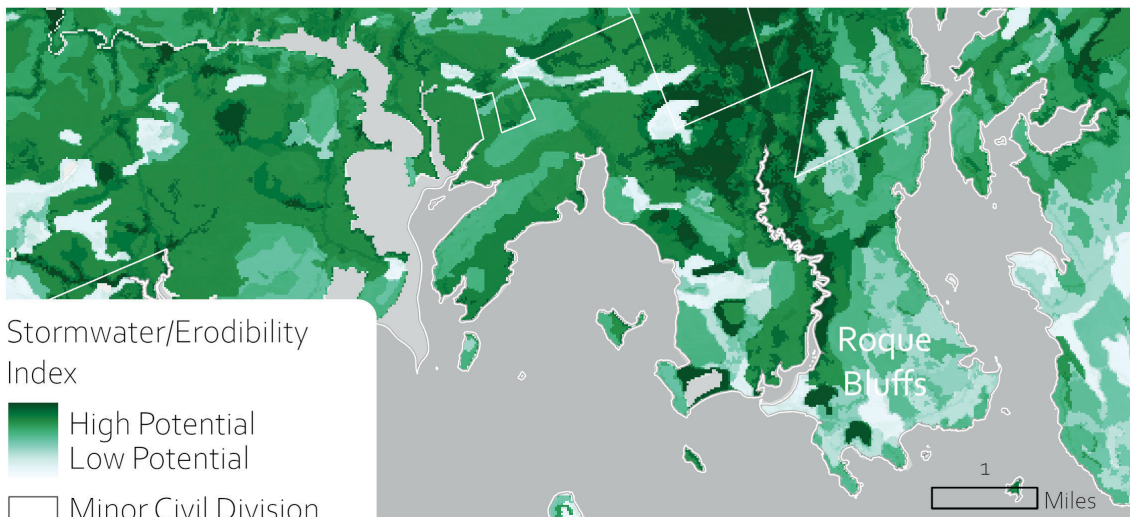
Stormwater/erodibility index at 30-m resolution, created by equally combining the stormwater flood hazard and soil erodibility indices. Higher combined stormwater flood hazard and soil erodibility potential is shown in darker green, while lower combined stormwater flood hazard and soil erodibility potential is shown in lighter green and white.

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ROUQE BLUFFS



ROUQE BLUFFS

Stormwater/Erodibility Index
 High Potential
 Low Potential
 Minor Civil Division

Combined stormwater flooding and soil erodibility index at 30-m resolution shown for Danforth, Machiasport, and Roque Bluffs. Higher combined stormwater flood hazard and soil erodibility potential is shown in darker green, while lower combined stormwater flood hazard and soil erodibility potential is shown in lighter green and white.

5 Infrastructure Risk From Hazards

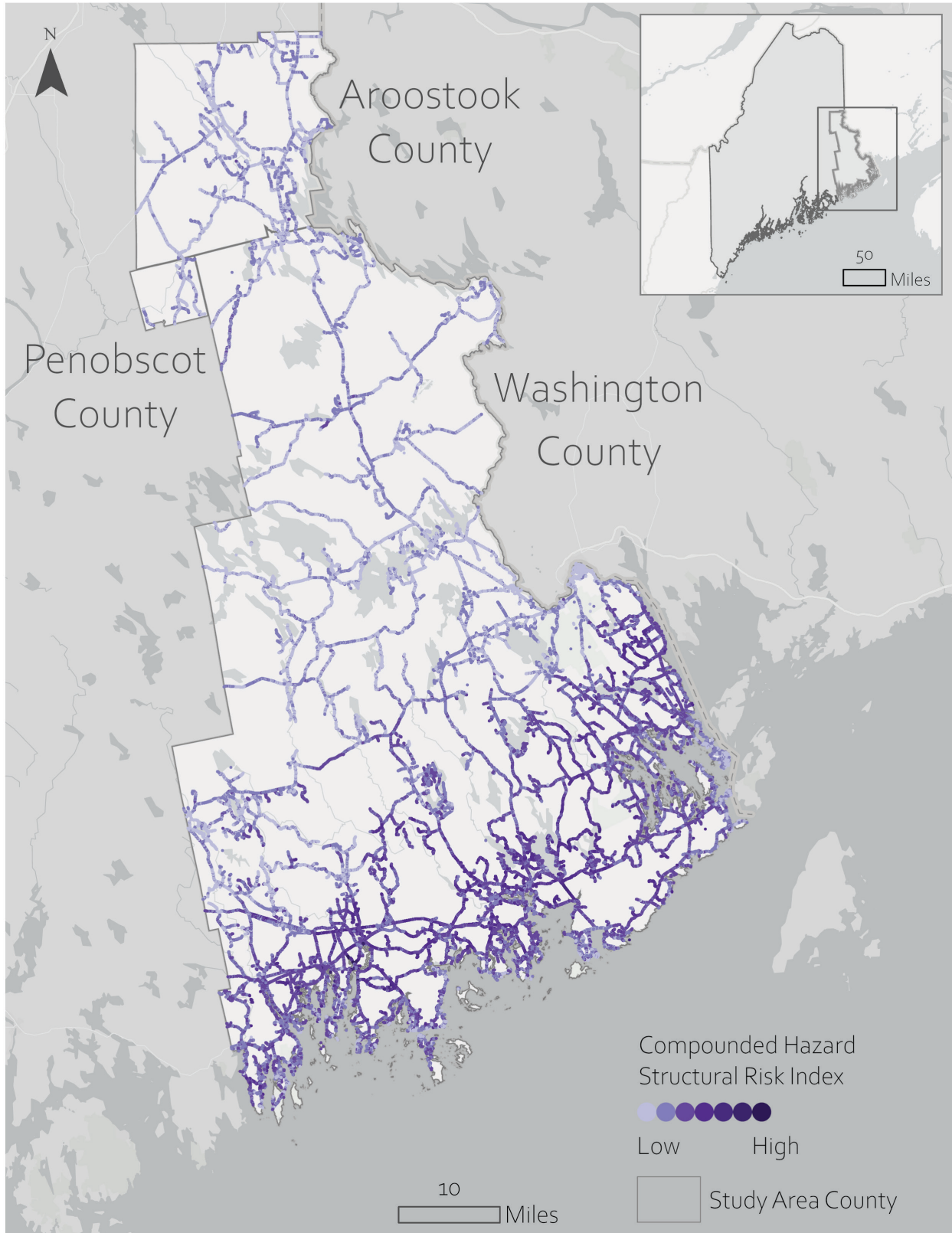
This section presents place-based infrastructure risk related to compounded structural risk from combined hazards, followed by infrastructure risk related to each included hazard type: storm surge flooding from a Category 2 hurricane, precipitation-based stormwater flooding, wildfire, and winter ice storms. Hazard values were assigned to each critical infrastructure point within the structural index (Section 7).

All map values are unitless index values relative to the study area. More information on the structural index and the presented hazards can be found in Sections 6 and 7.

These maps highlight where **critical infrastructure faces multiple hazards**, which supports decision makers in **prioritizing resilience investments, emergency planning, and risk-reduction efforts**.



Bald eagle flying above Indian Township. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.



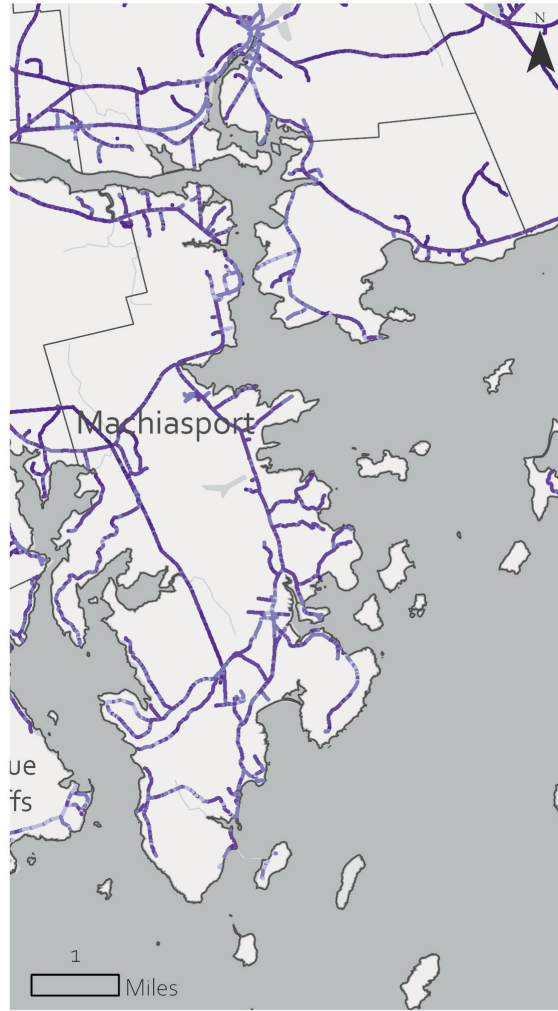
Compounded hazard structural risk index from the combined storm surge,* stormwater flooding, winter ice storm, and wildfire hazard indices for each structural index point. Darker purple points have a higher risk of being impacted by these combined hazards than lighter purple points.

*Coastal storm surge values are available only for coastal infrastructure.

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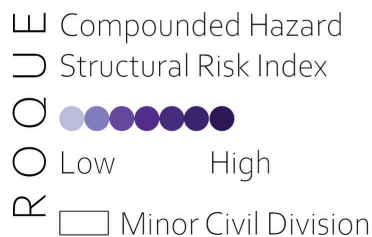
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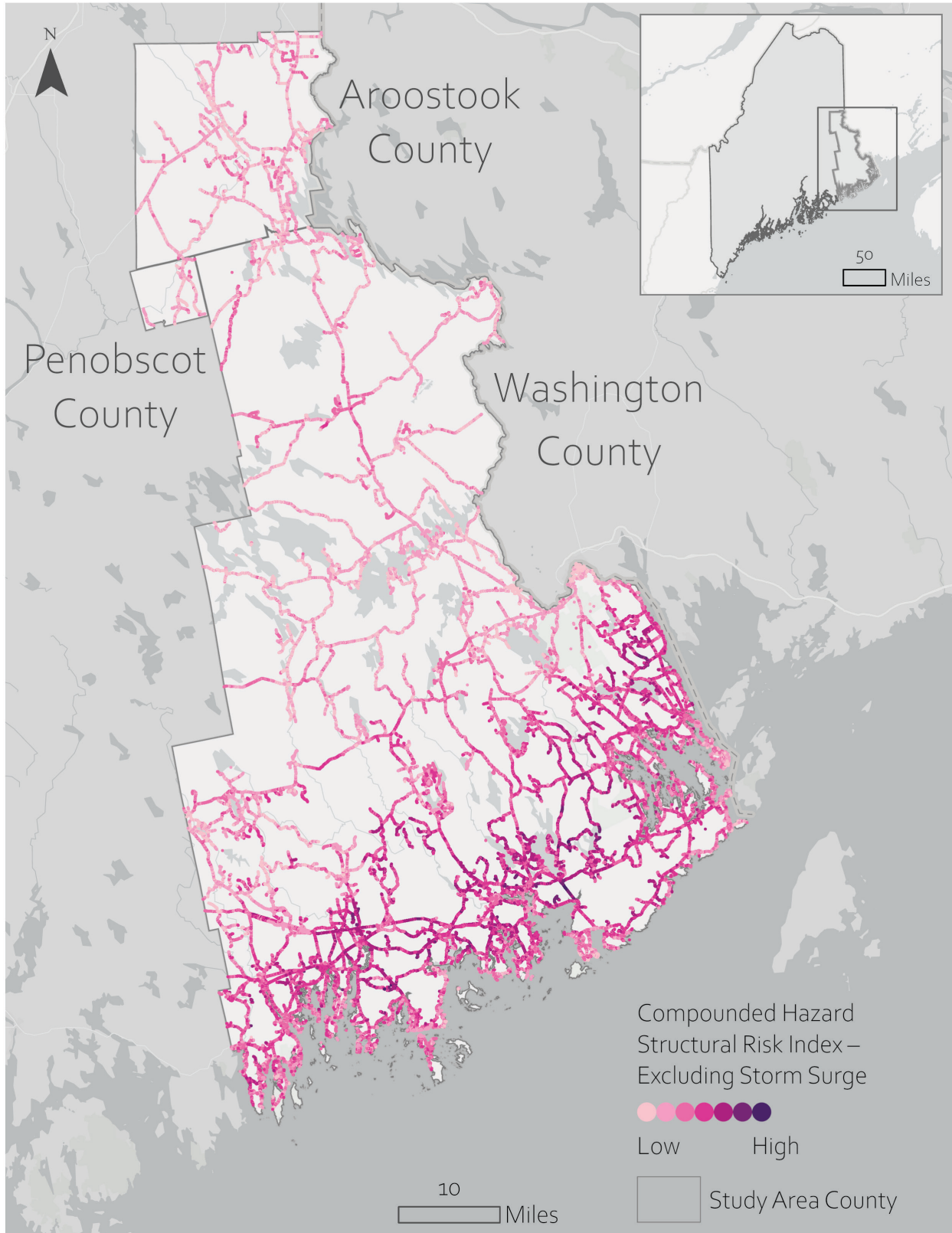


ROQUE BLUFFS



Compounded hazard structural risk index from the combined storm surge*, stormwater flooding, winter ice storm, and wildfire hazard indices for each structural index point, shown for Danforth, Machiasport, and Roque Bluffs. Darker purple points have a higher risk of being impacted by these combined hazards than lighter purple points.

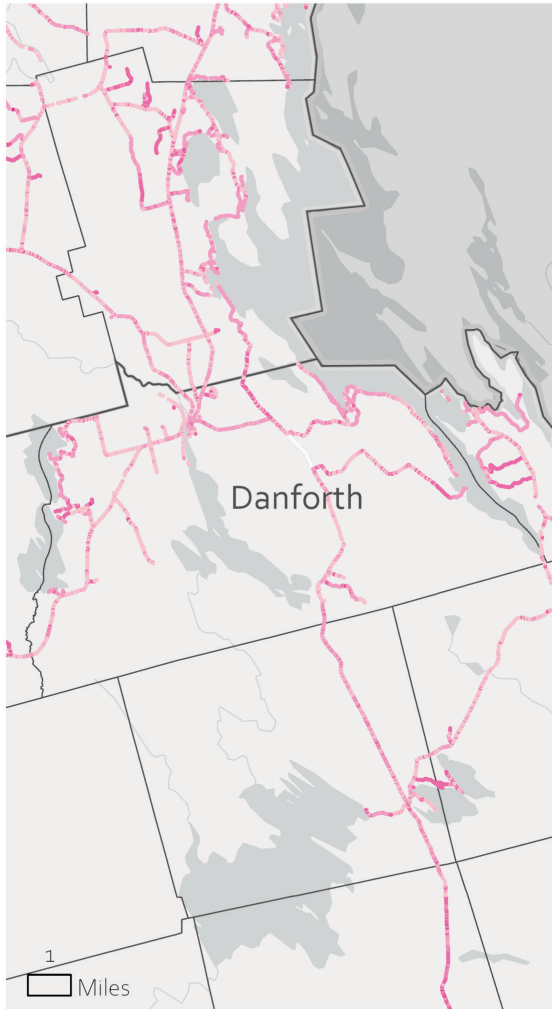
*Coastal storm surge values are available only for coastal infrastructure.



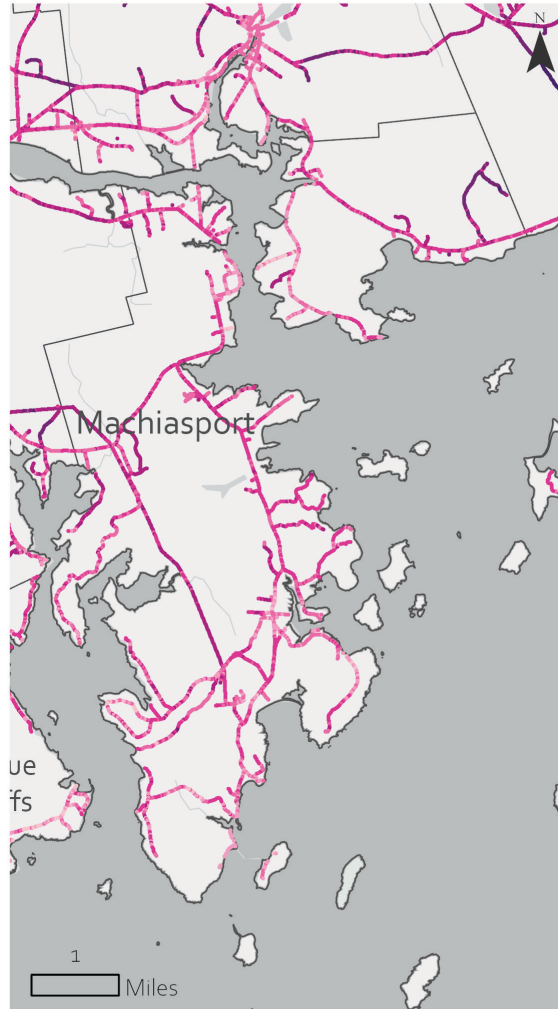
Compounded hazard structural risk index from the combined stormwater flooding, winter ice storm, and wildfire hazard indices* for each structural index point. Darker pink points have a higher risk of being impacted by these combined hazards than lighter pink points.

*The storm surge index was omitted from this structural risk index due to limited coverage within the study area.

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ROQUE BLUFFS

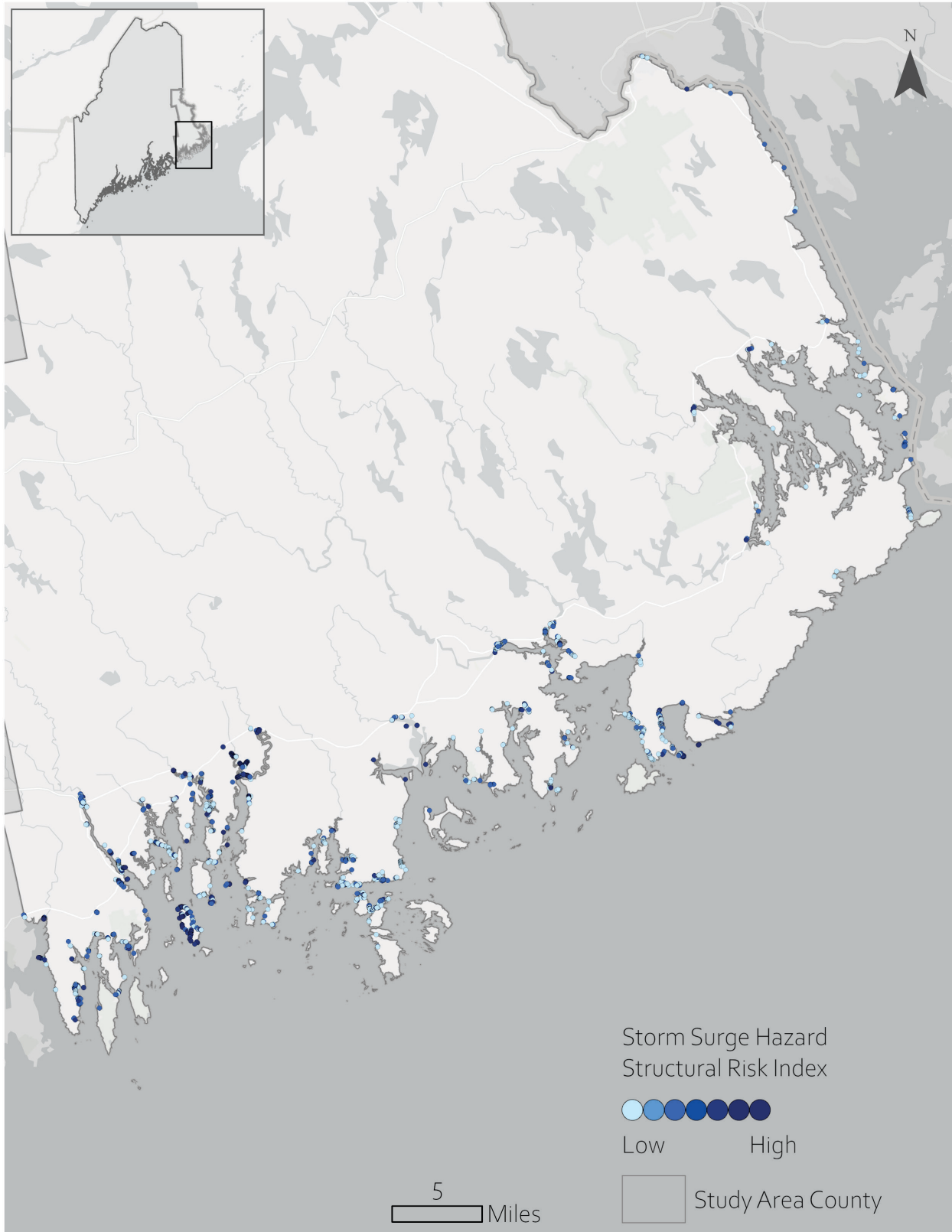
Compounded Hazard Structural Risk Index – Excluding Storm Surge

Low High

Minor Civil Division

Compounded hazard structural risk index from the combined stormwater flooding, winter ice storm, and wildfire hazard indices for each structural index point, shown for Danforth, Machiasport, and Roque Bluffs. Darker pink points have a higher risk of being impacted by these combined hazards than lighter pink points.

*The storm surge index was omitted from this structural risk index due to limited coverage within the study area.



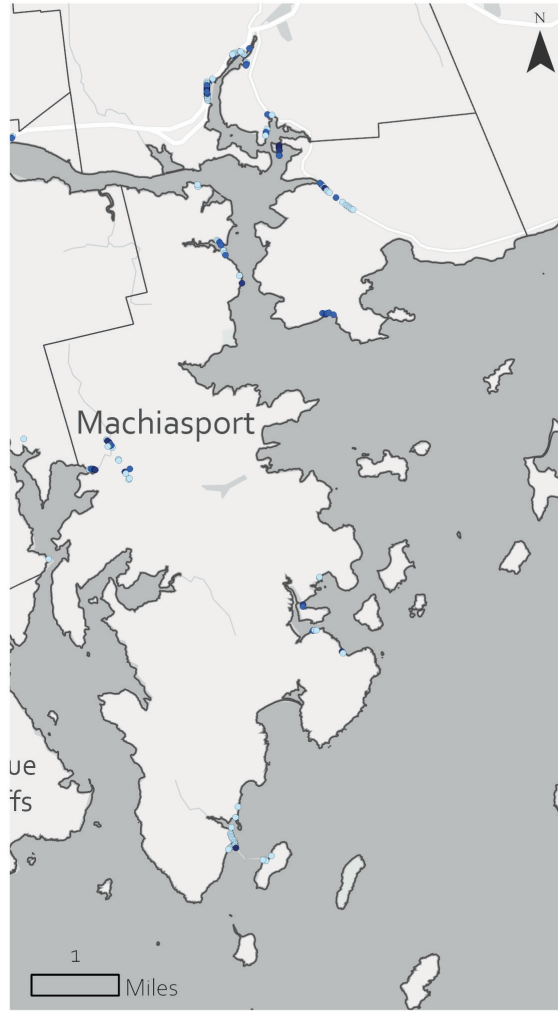
Structural risk index from storm surge hazard for each structural index point.* Darker blue points have a higher risk of being impacted by storm surge than lighter blue points.

*Structural points outside of storm surge inundation areas are not shown.

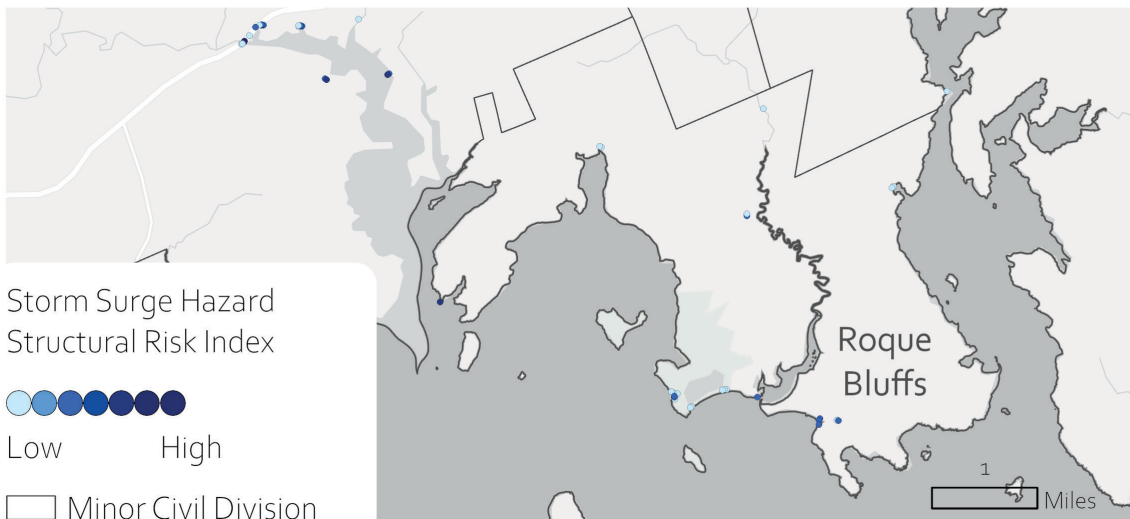
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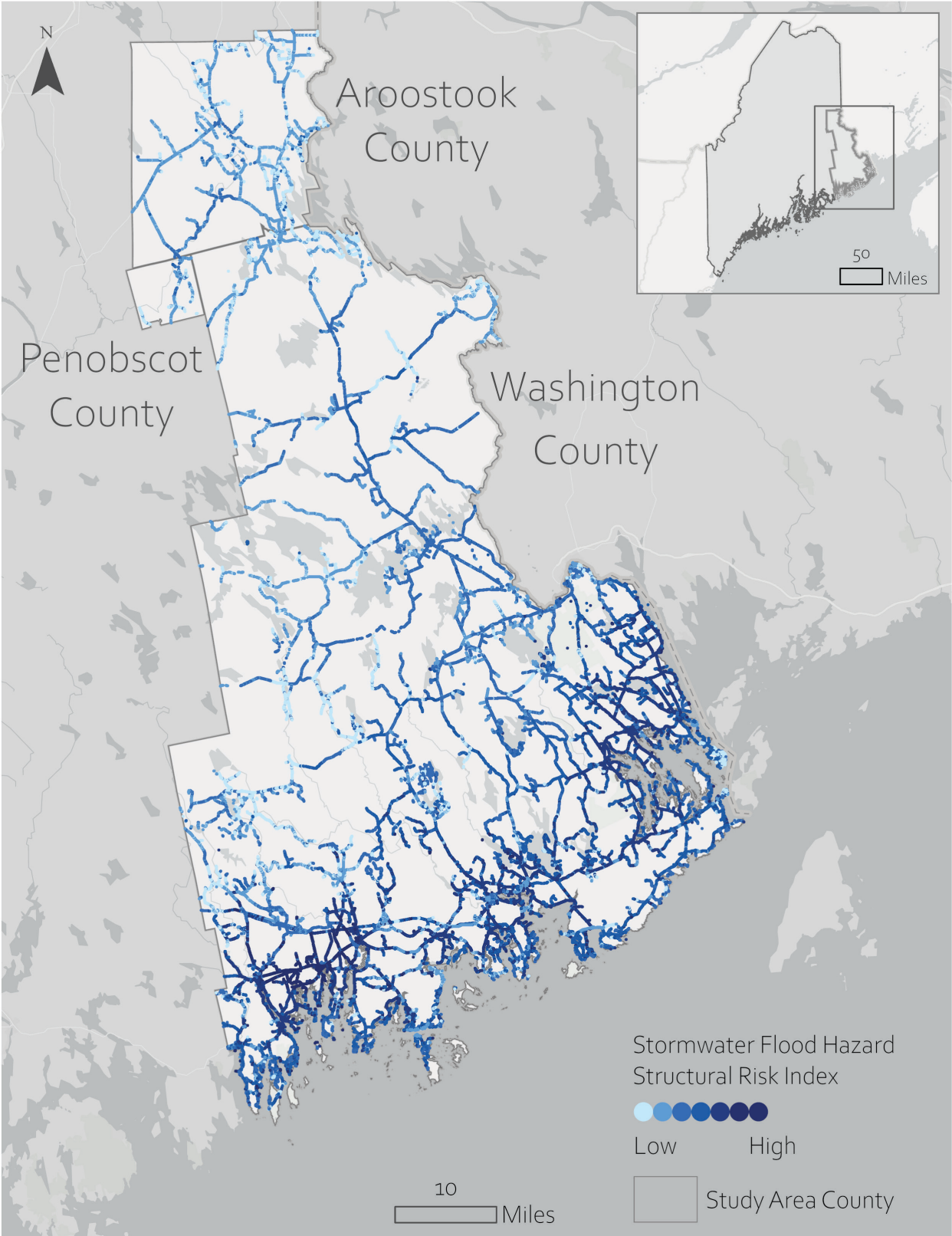
Storm Surge Hazard
Structural Risk Index

Low High

Minor Civil Division

Structural risk index from storm surge hazard for each structural index point,* shown for Danforth, Machiasport, and Roque Bluffs. Darker blue points have a higher risk of being impacted by storm surge than lighter blue points.

*Structural points outside of storm surge inundation areas are not shown.

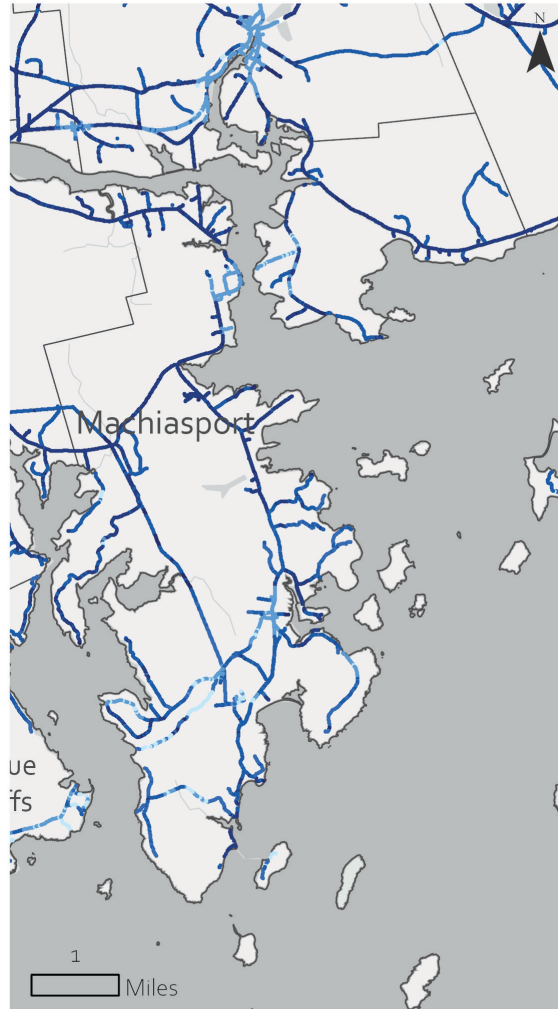


Structural risk index from stormwater flood hazard for each structural index point. Darker blue points have a higher risk of being impacted by precipitation-based stormwater flooding than lighter blue points.

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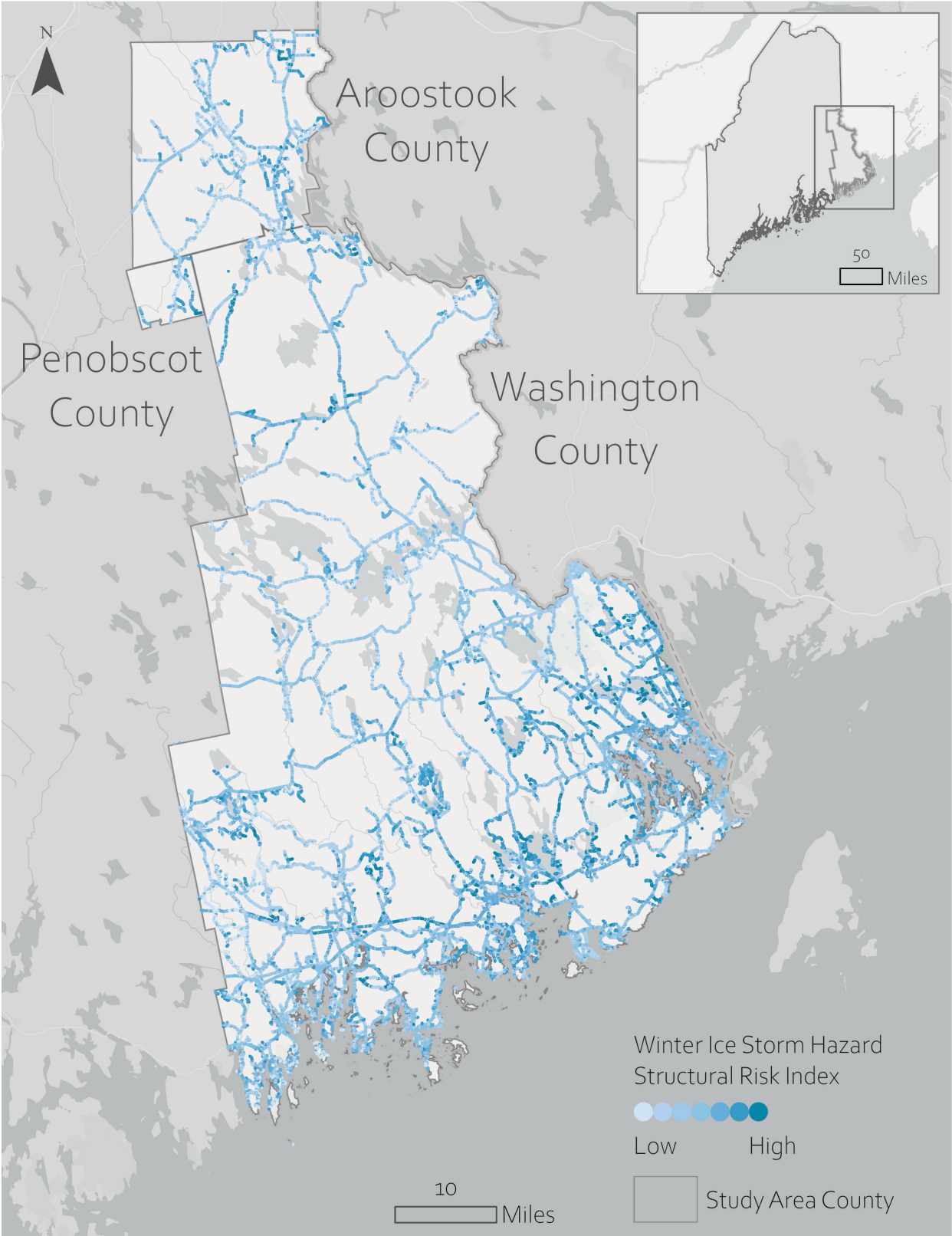
ROQUE BLUFFS



ROQUE BLUFFS

Stormwater Flood Hazard
Structural Risk Index
● ● ● ● ● ● ● ●
Low High
□ Minor Civil Division

Structural risk index from stormwater flood hazard for each structural index point, shown for Danforth, Machiasport, and Roque Bluffs. Darker blue points have a higher risk of being impacted by precipitation-based stormwater flooding than lighter blue points.



Structural risk index from winter ice storm hazard for each structural index point. Darker blue points have a higher risk of being impacted by winter ice storms than lighter blue points.

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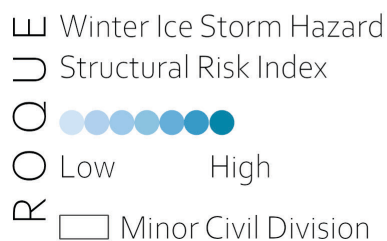
MACHIASPORT



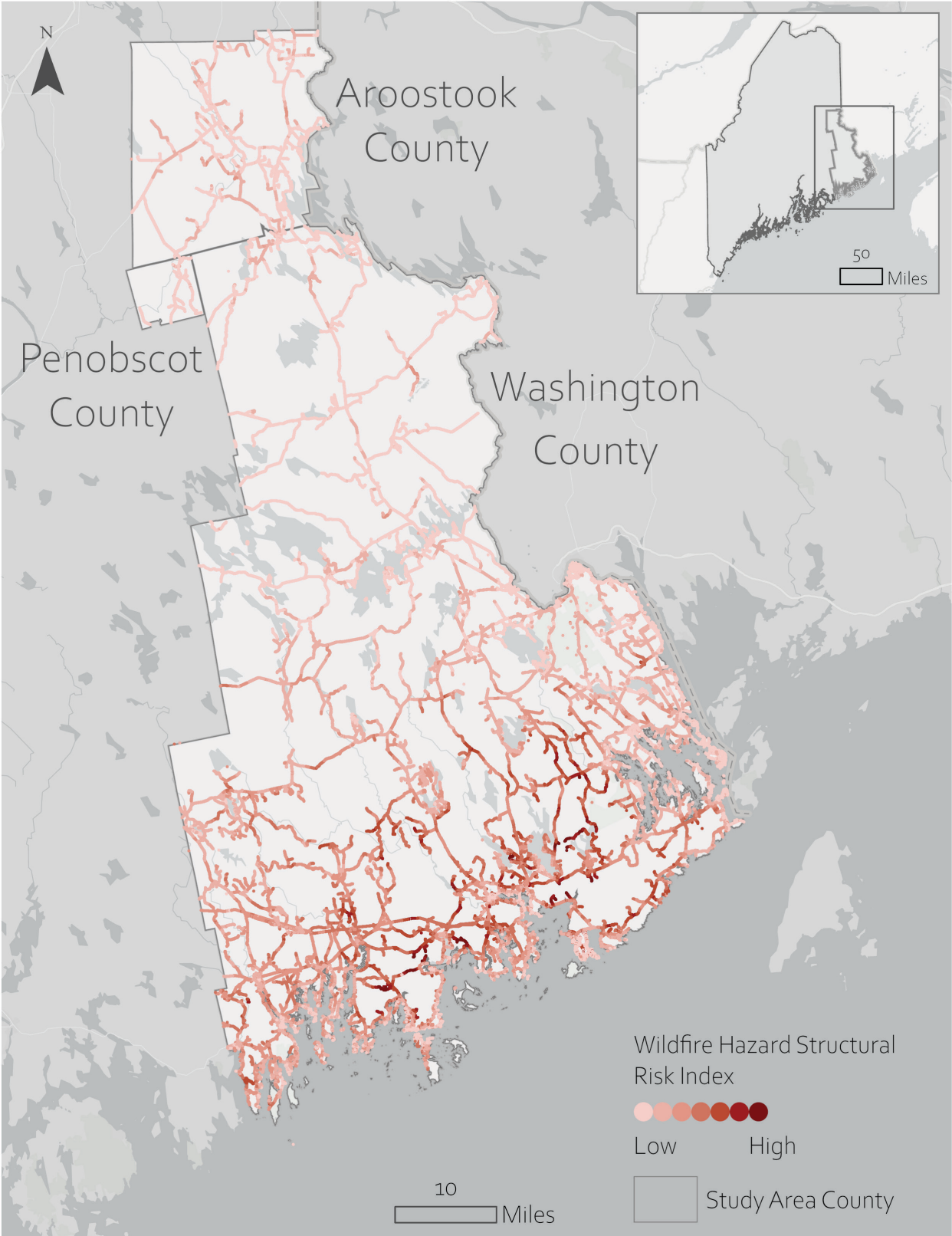
ROQUE BLUFFS



ROQUE BLUFFS



Structural risk index from winter ice storm hazard for each structural index point, shown for Danforth, Machiasport, and Roque Bluffs. Darker blue points have a higher risk of being impacted by winter ice storms than lighter blue points.

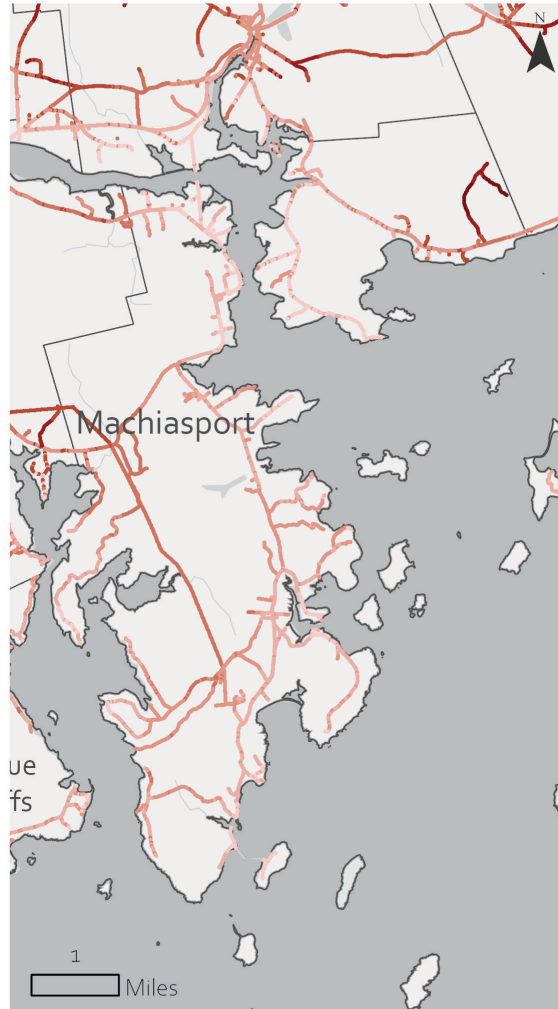


Structural risk index from wildfire hazard for each structural index point. Darker red points have a higher risk of being impacted by wildfires than lighter red points.

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ROQUE BLUFFS



ROQUE BLUFFS

Wildfire Hazard Structural Risk Index

Low High

Minor Civil Division

Structural risk index from wildfire hazard for each structural index point, shown for Danforth, Machiasport, and Roque Bluffs. Darker red points have a higher risk of being impacted by wildfires than lighter red points.

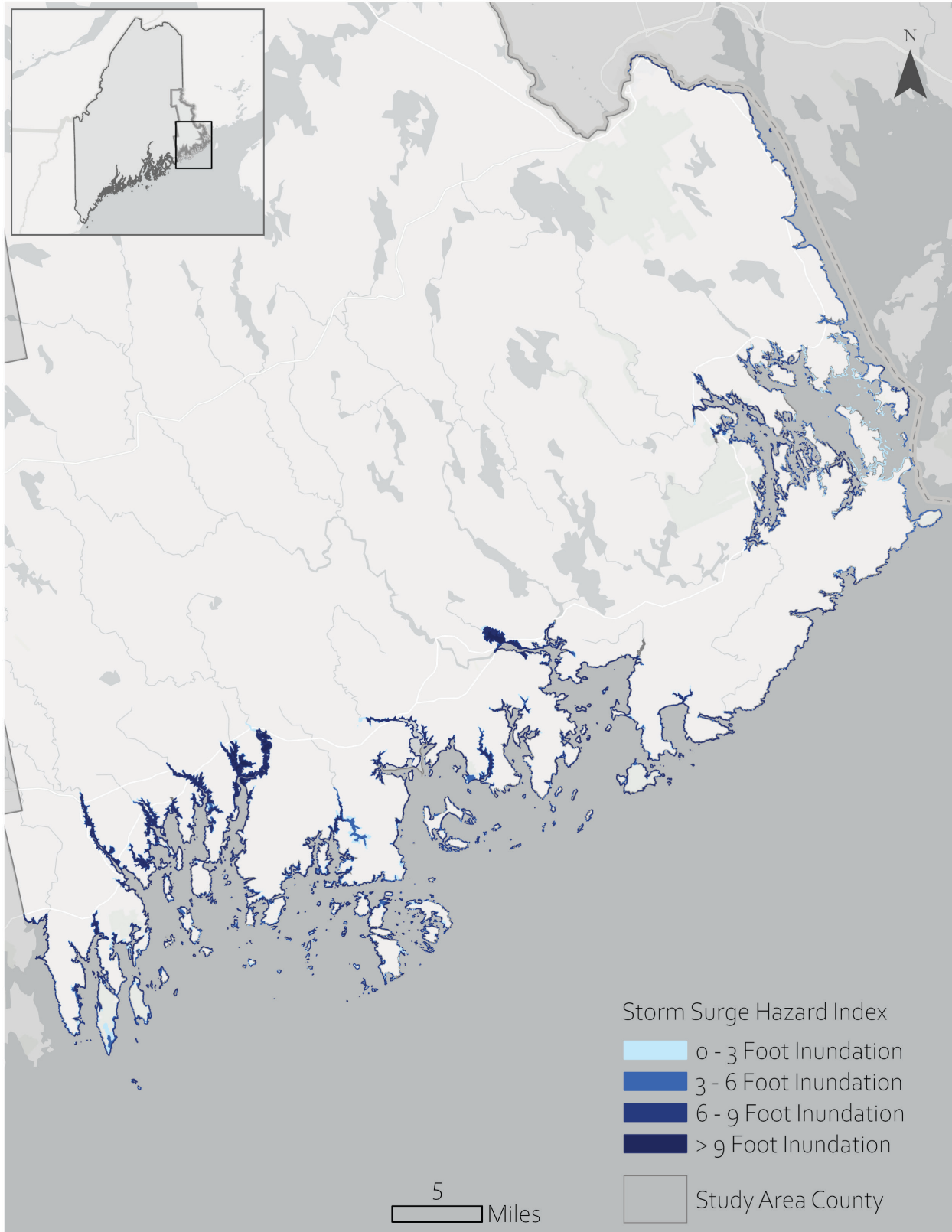
6 Hazard Components

This section presents all environmental hazard components, including coastal storm surge flooding from a Category 2 hurricane, precipitation-based stormwater flooding, wildfire, and winter ice storms. Final index maps are first shown, followed by any contributing indicator maps. When indicators were combined, indicators were equally weighted. Indicator maps highlight specific hazard metrics, and index maps reveal broader patterns. All map values are unitless index values relative to the study area, excluding storm surge.

These maps equip decision makers to **identify areas at risk from key environmental hazards, focus mitigation efforts, improve planning, and target priority areas** for further investigation.



Port in Rockland, Maine. Credit: Amy Freitag, NOAA NCCOS.

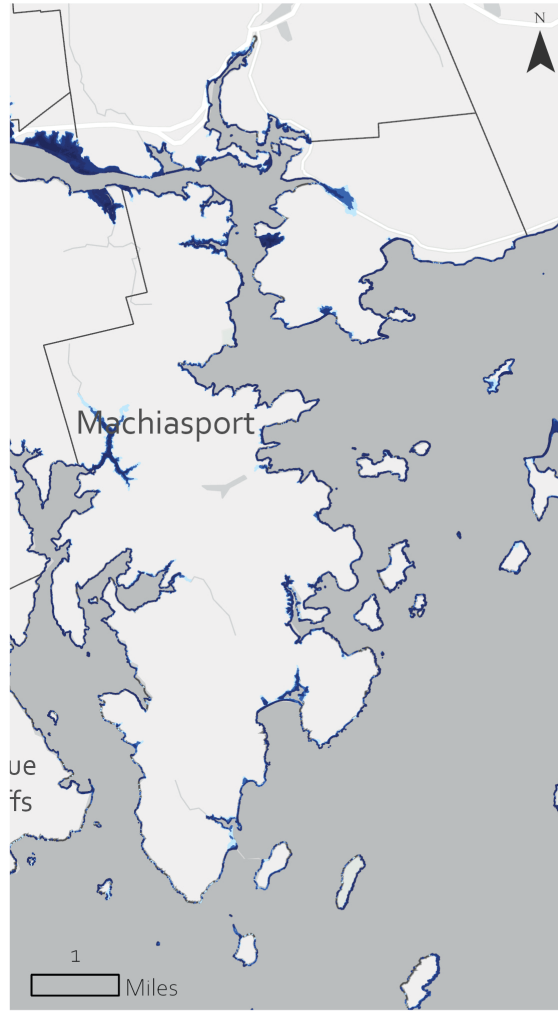


Storm surge hazard index from a Category 2 hurricane grouped by inundation depth. Shallower flood depths are shown in lighter blue, while deeper flood depths are shown in darker blue.

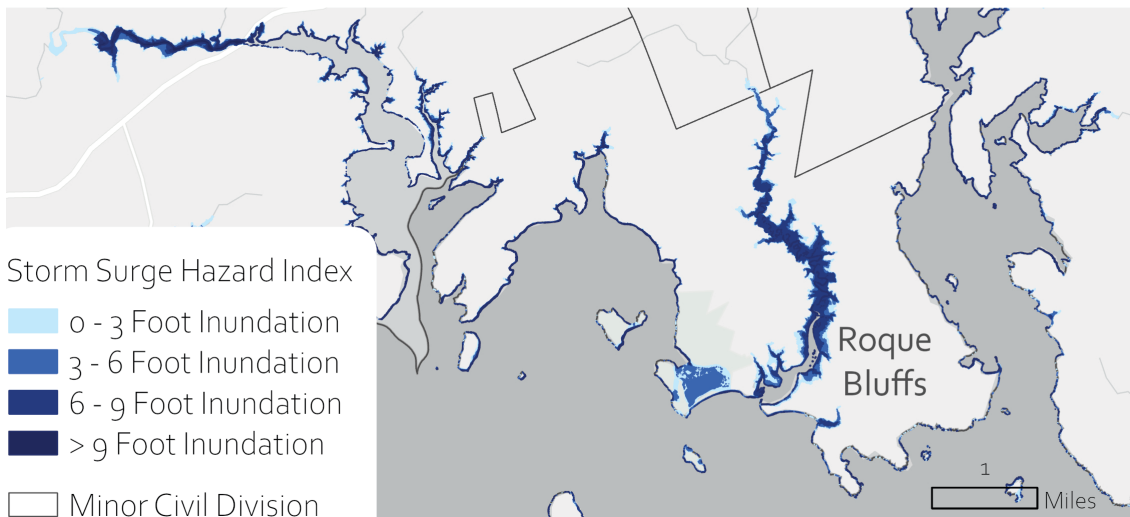
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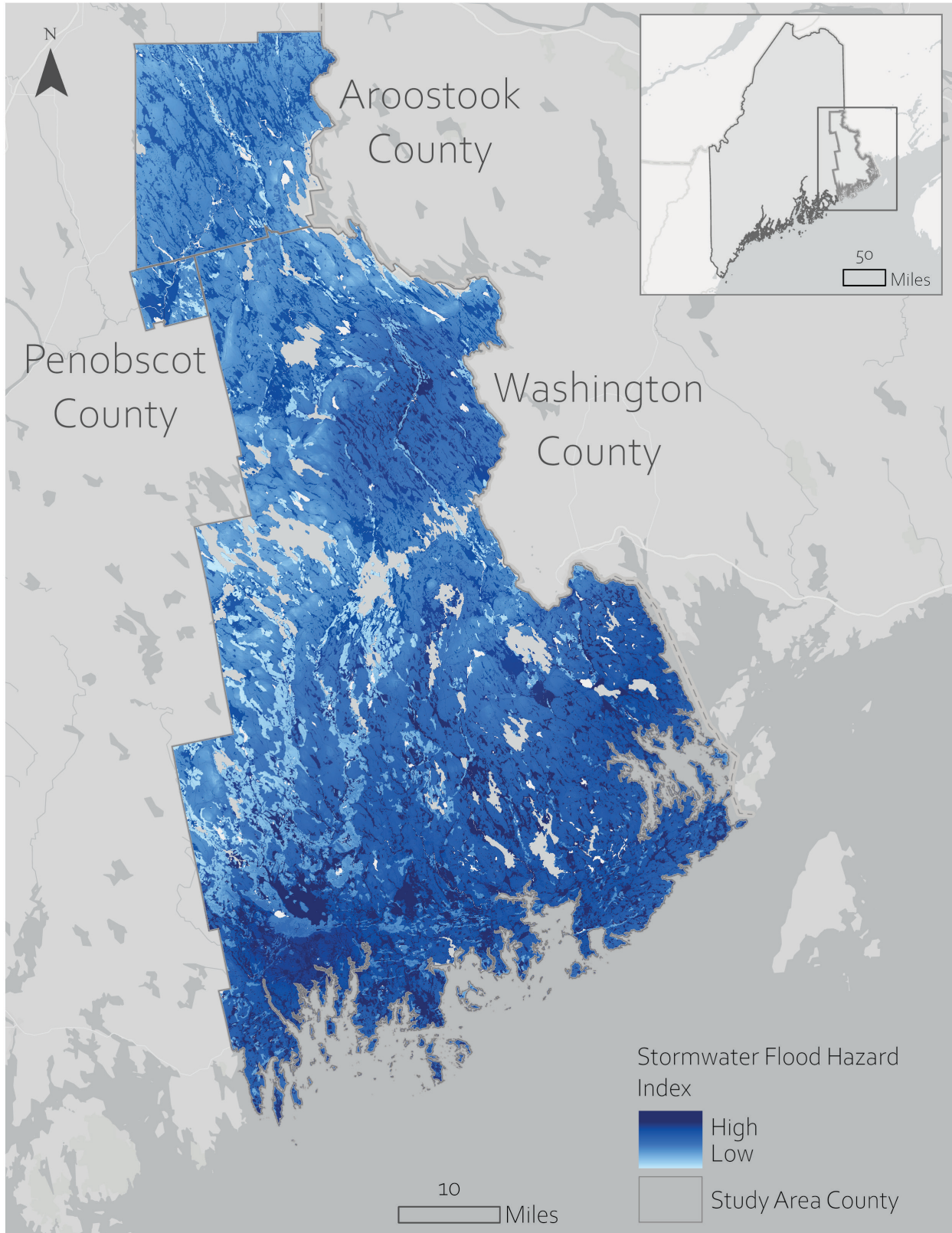


ROQUE BLUFFS



ROQUE BLUFFS

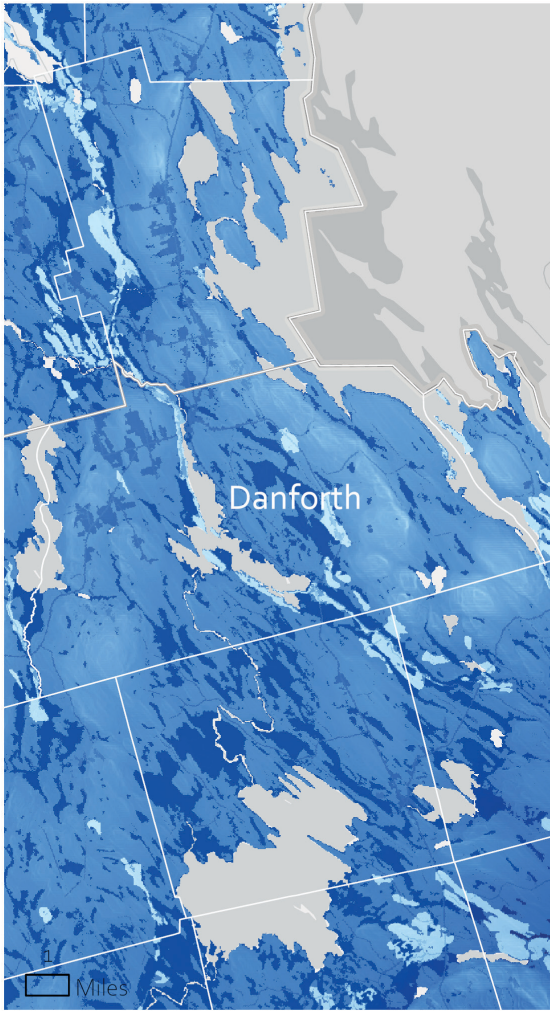
Storm surge hazard index from a Category 2 hurricane grouped by inundation depth shown for Danforth, Machiasport, and Roque Bluffs. Shallower flood depths are shown in lighter blue, while darker flood depths are shown in darker blue.



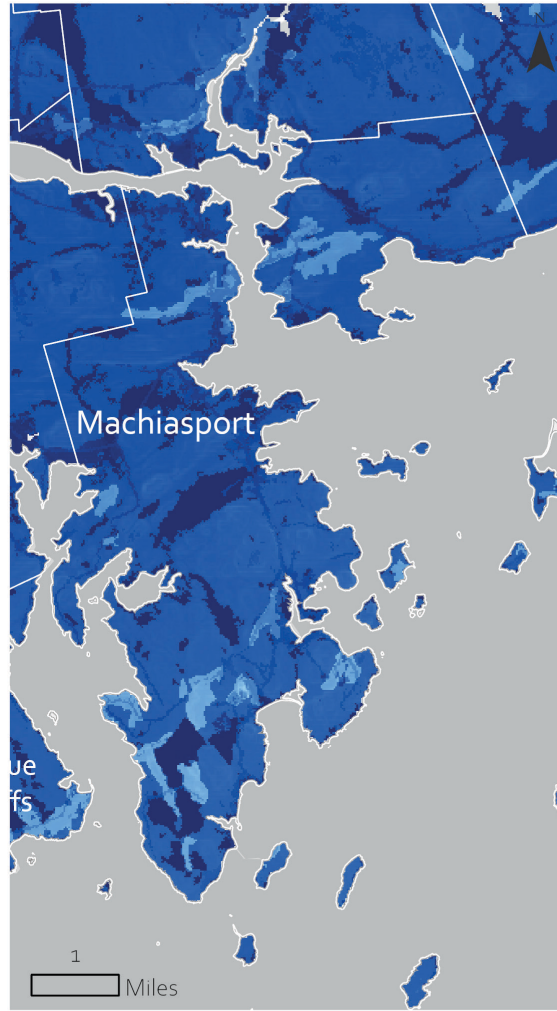
Stormwater flood hazard index* at 30-m resolution, created by combining seven indicators equally: flow accumulation, rainfall intensity, geology (hydrologic soil group), land use/land cover, slope, elevation, and drainage network. Higher potential for precipitation-based flooding is shown in darker blue, while lower potential is shown in lighter blue.

*This index incorporates coarser (800-m) resolution precipitation data (to estimate the rainfall intensity indicator) that were resampled to 30-m resolution for assessment integration.

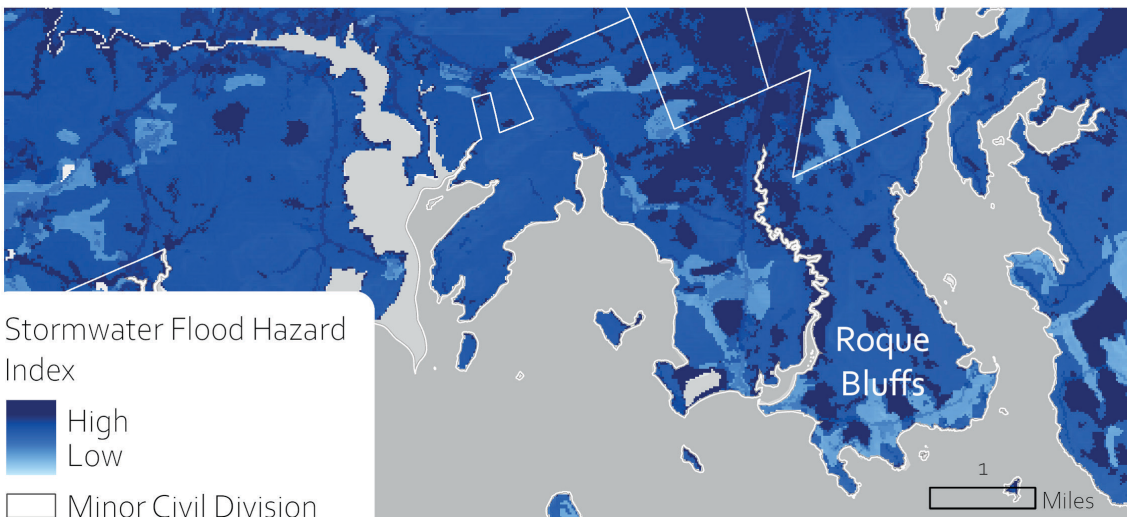
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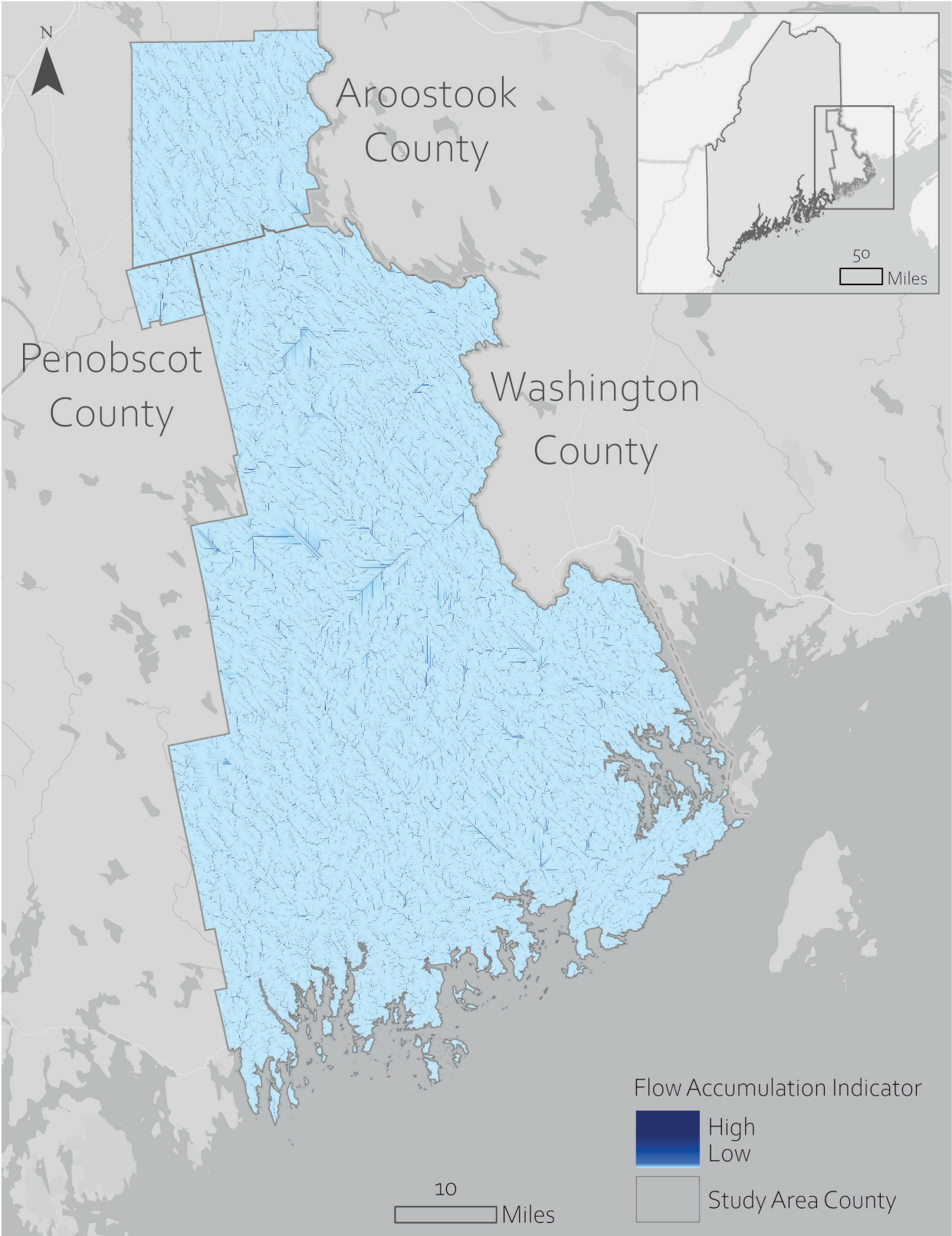
ROQUE BLUFFS

Stormwater Flood Hazard Index

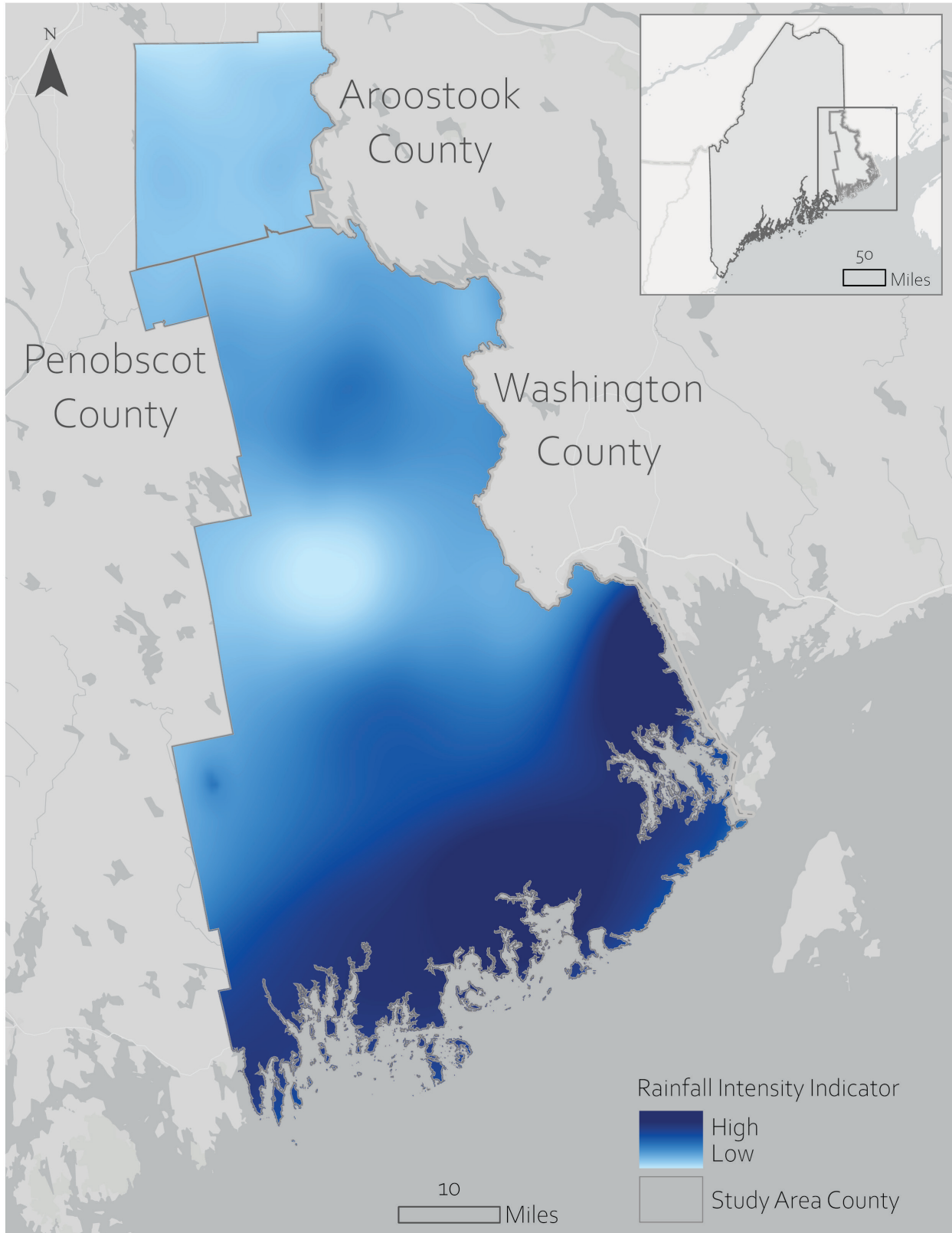
- High
- Low
- Minor Civil Division

Stormwater flood hazard index* at 30-m resolution shown for Danforth, Machiasport, and Roque Bluffs. Higher potential for precipitation-based flooding is shown in darker blue, while lower potential is shown in lighter blue.

*This index incorporates coarser (800-m) resolution precipitation data (to measure rainfall intensity) that were resampled to 30-m resolution for assessment integration.

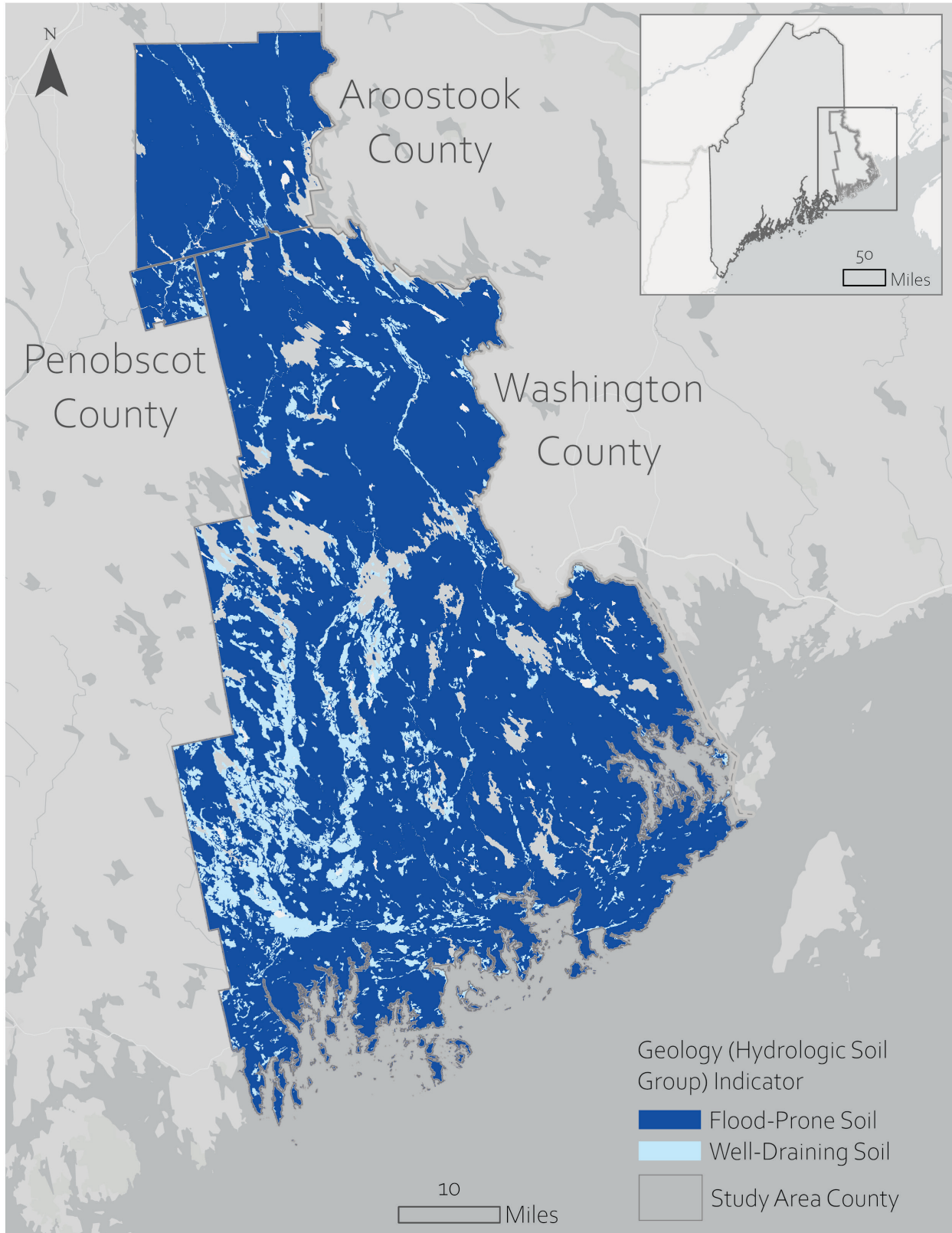


Flow accumulation indicator in 30-m resolution, derived from a digital elevation model (DEM), from higher flow accumulation in darker blue to lower flow accumulation in lighter blue. This indicator is the first of seven indicators for this assessment’s stormwater flood hazard index.

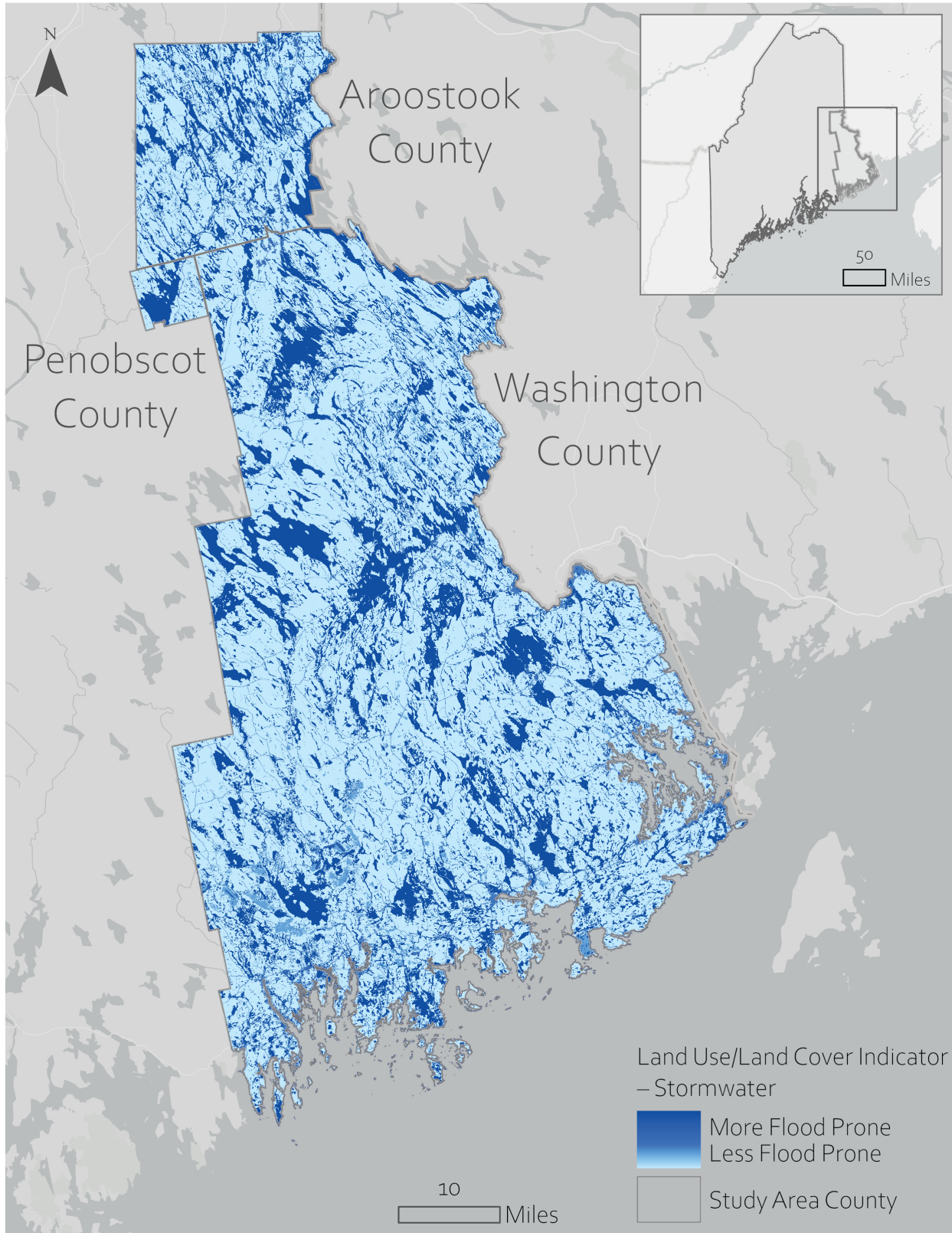


Rainfall intensity indicator* in 30-m resolution, using annual precipitation data to estimate intensity. Higher rainfall intensity is shown in darker blue, while lower rainfall intensity is in lighter blue. This indicator is the second of seven indicators for this assessment’s stormwater flood hazard index.

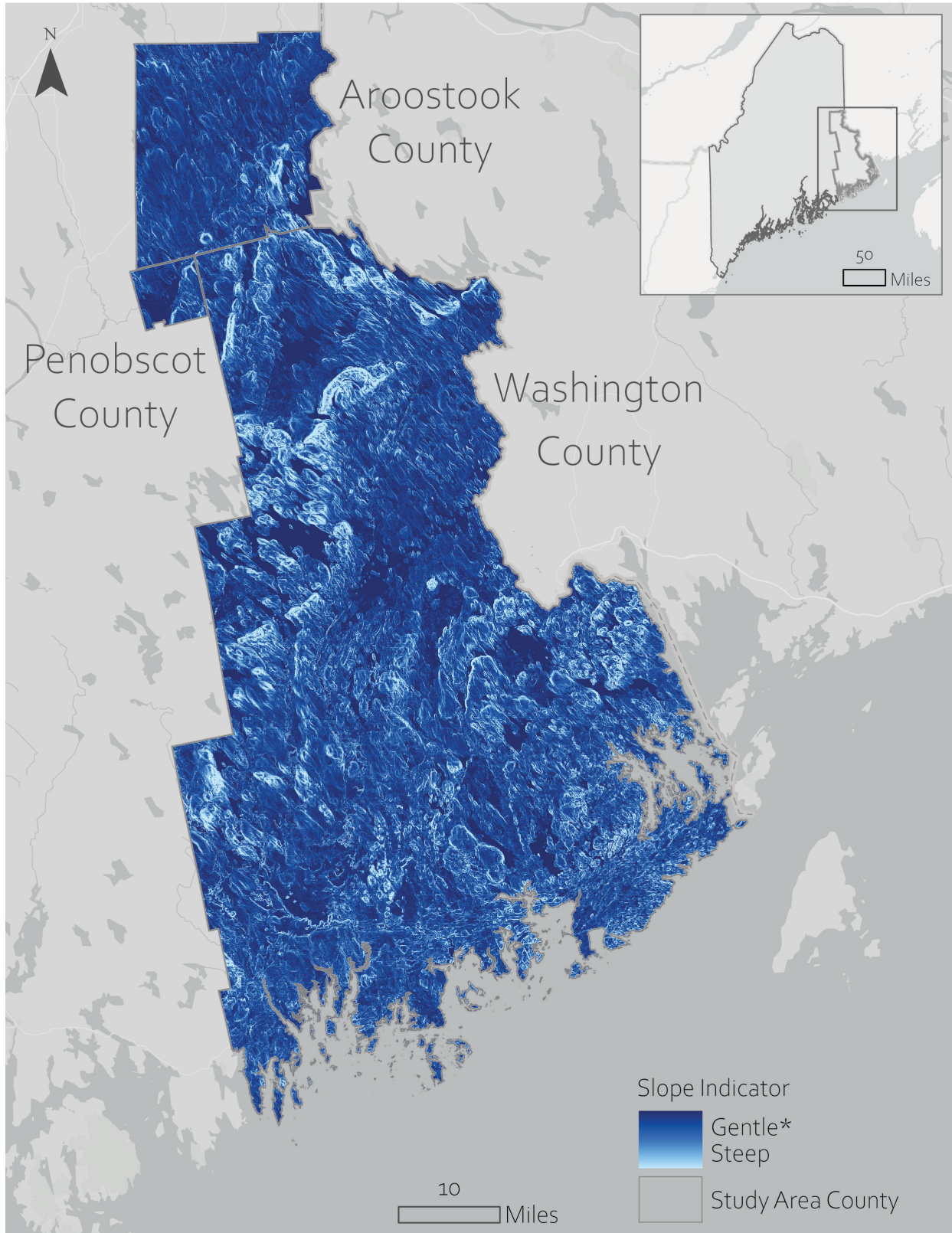
*This indicator uses coarser (800-m) resolution data that were resampled to 30-m resolution for assessment integration and should be used only to assess broad geographic trends.



Geology (hydrologic soil group) indicator in 30-m resolution, reclassified by drainage capacity and normalized. Flood-prone soils are shown in dark blue, while well-draining soils are in light blue. This indicator is the third of seven indicators for this assessment's stormwater flood hazard index.

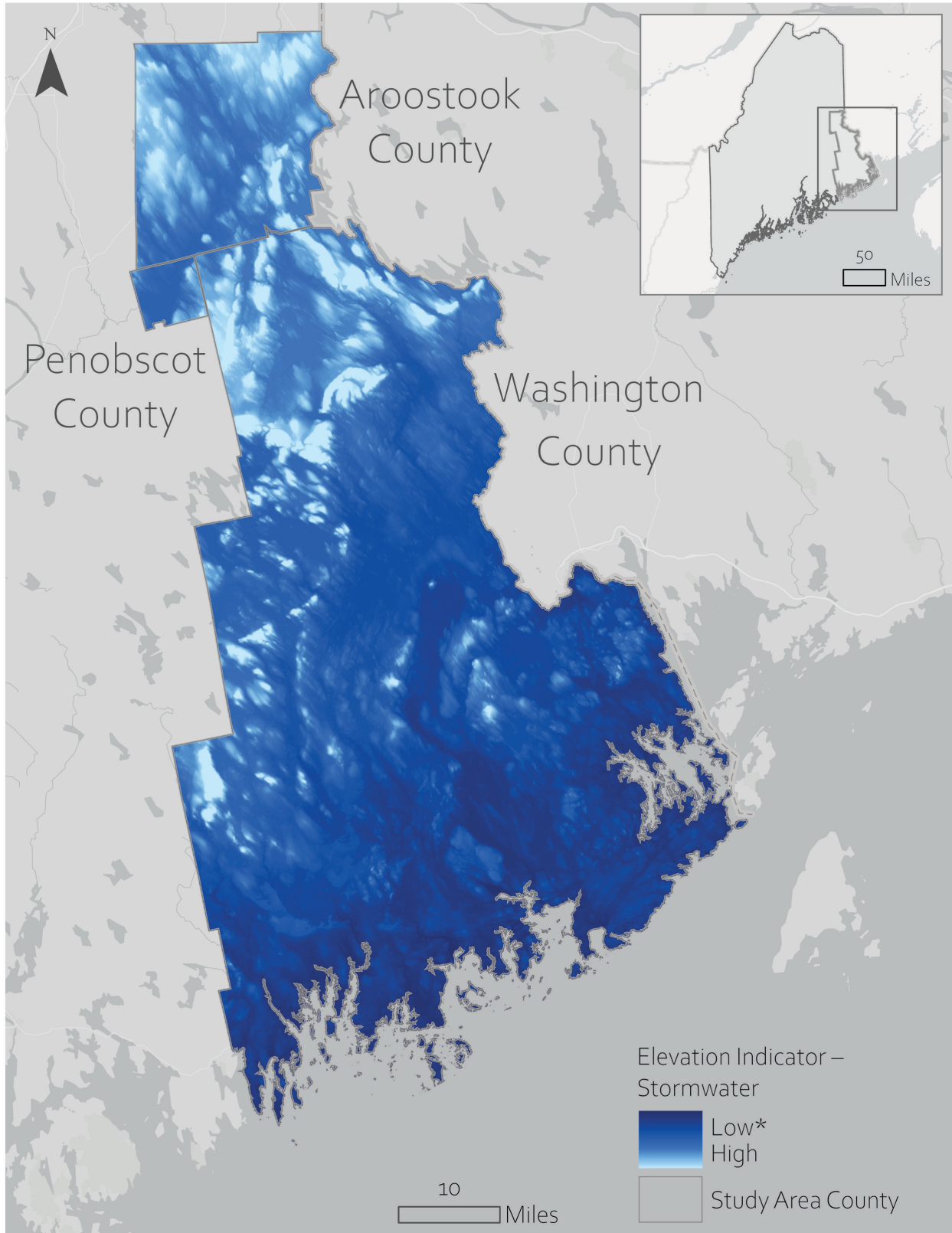


Land use/land cover indicator in 30-m resolution, grouped and reclassified by potential flood risk. More flood-prone land use/land cover types are shown in darker blue, while less flood-prone land use/land cover types are in lighter blue. This indicator is the fourth of seven indicators for this assessment’s stormwater flood hazard index.



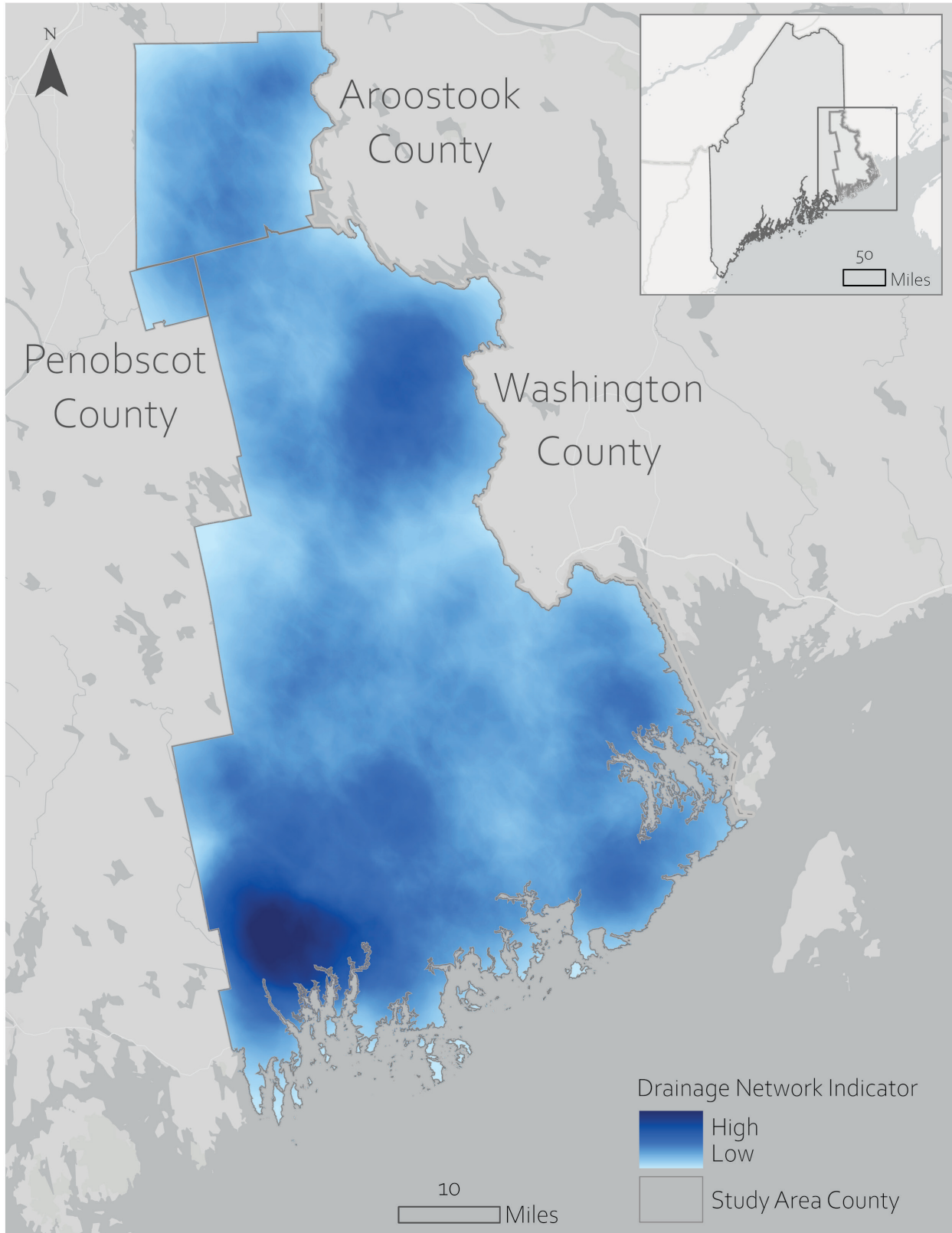
Slope indicator in 30-m resolution, derived from a digital elevation model (DEM). Gentler, more flood-prone slopes are shown in darker blue, while steeper, less flood-prone slopes are shown in lighter blue. This indicator is the fifth of seven indicators for this assessment’s stormwater flood hazard index.

*Gentler slopes are more flood prone.

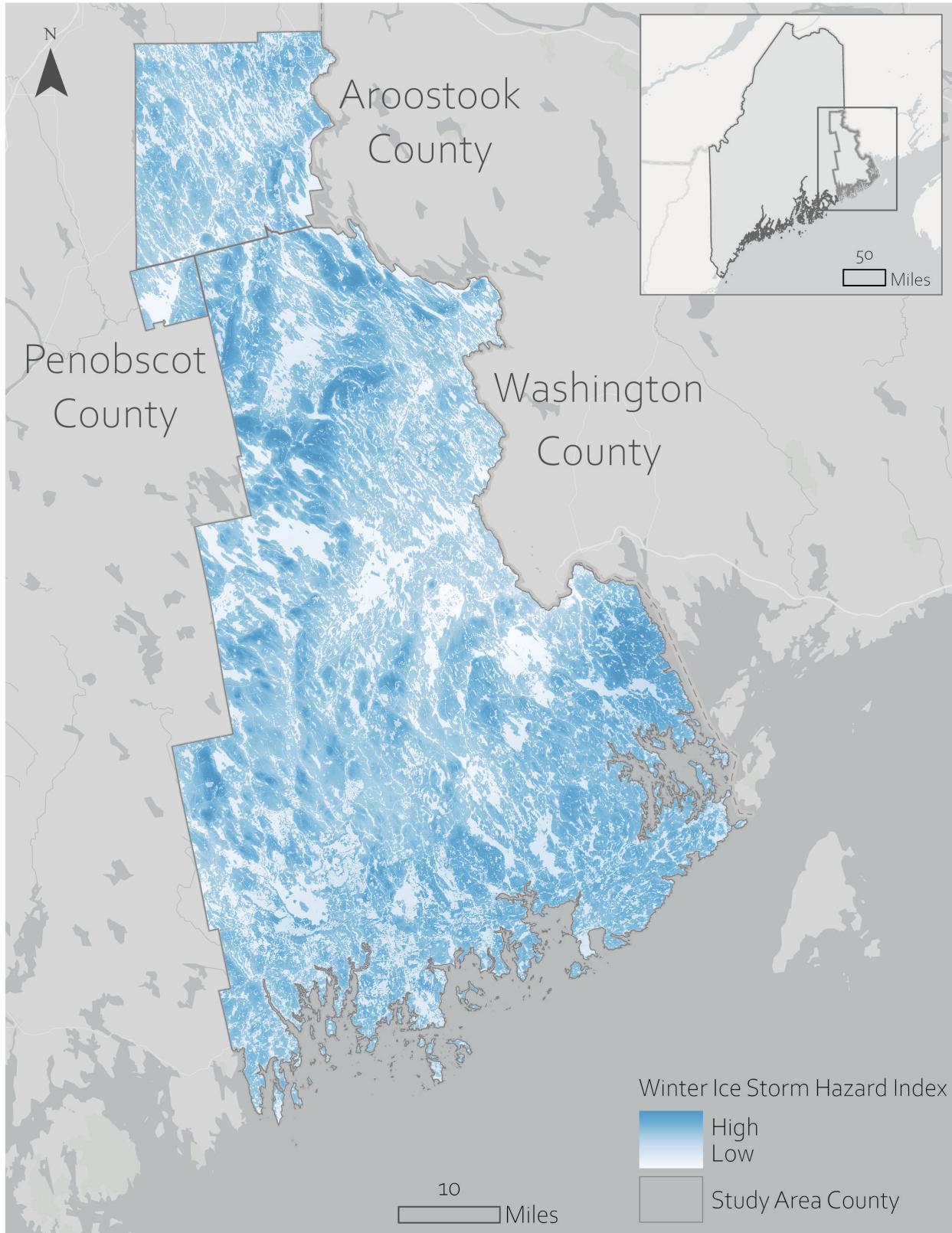


Elevation indicator in 30-m resolution, derived from a digital elevation model (DEM). Lower elevations that are generally more flood prone are shown in darker blue, while higher elevations that are generally less flood prone are shown in lighter blue. This indicator is the sixth of seven indicators for this assessment’s stormwater flood hazard index.

*Lower elevations are more flood prone.



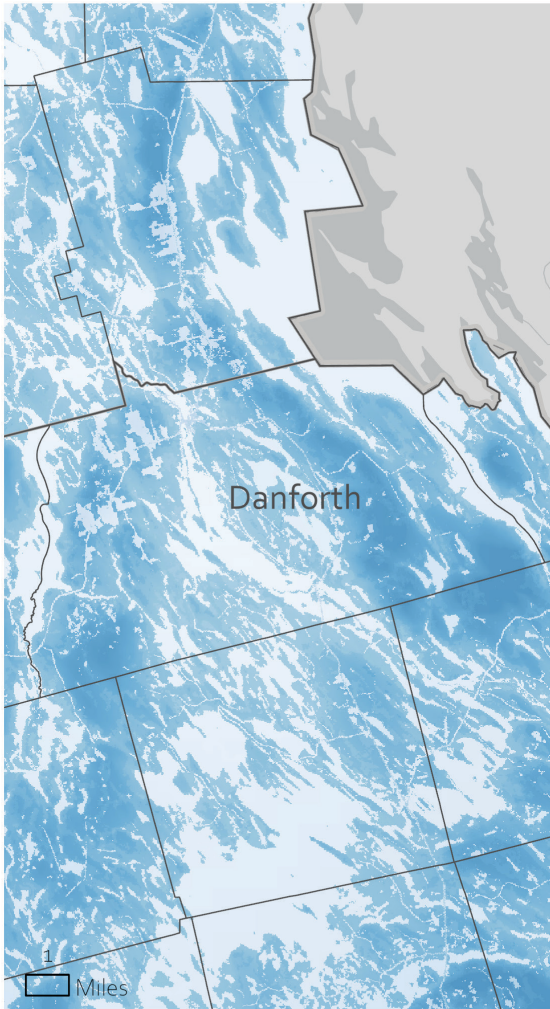
Drainage density in 30-m resolution, derived from a national hydrography dataset. Higher drainage density that is generally more flood prone is shown in darker blue, while lower drainage density that is generally less flood prone is shown in lighter blue. This indicator is the seventh of seven indicators for this assessment’s stormwater flood hazard index.



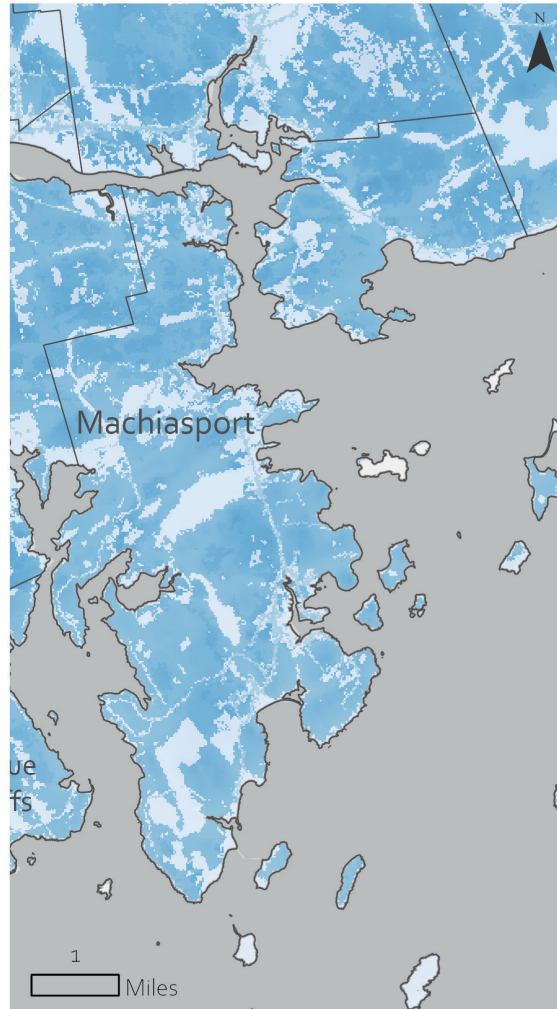
Winter ice storm hazard index* at 30-m resolution, created by combining three indicators equally: elevation, land use/land cover, and winter precipitation. Higher ice storm hazard is shown in darker blue, while lower ice storm hazard is in lighter blue and white.

*This index incorporates coarser (800-m) resolution precipitation data (to measure winter precipitation) that were resampled to 30-m resolution for assessment integration.

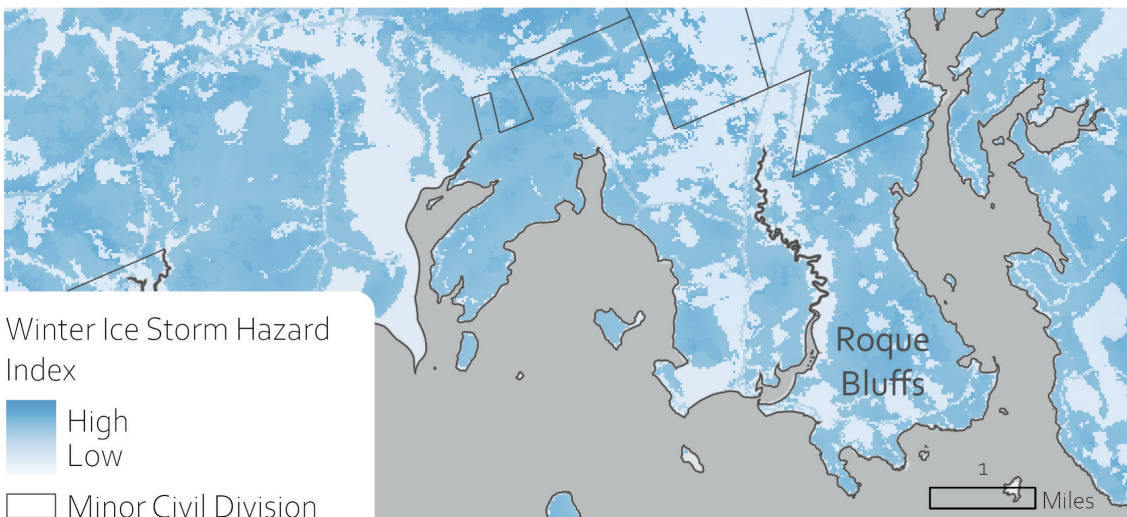
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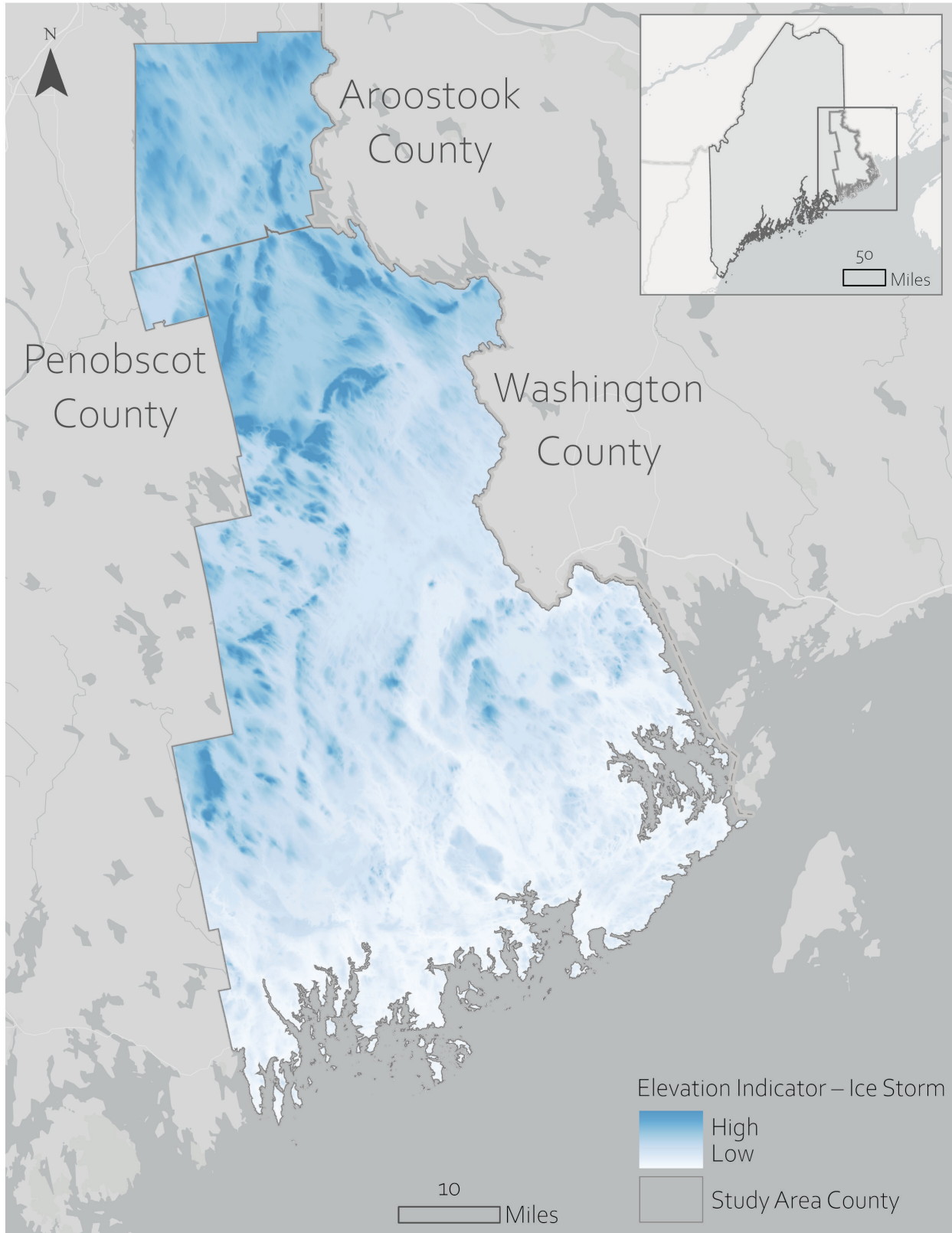


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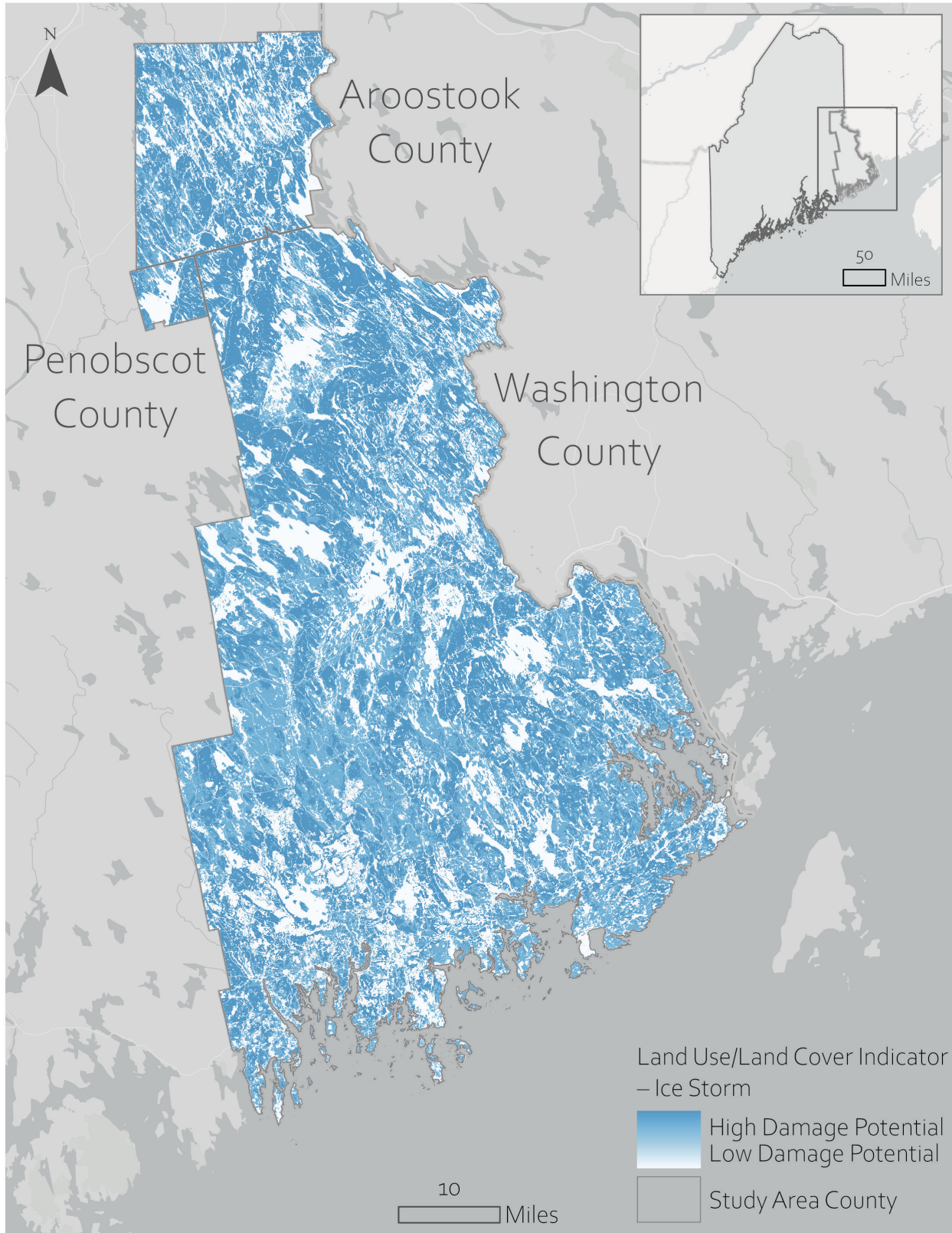
Winter Ice Storm Hazard Index
 High
 Low
 Minor Civil Division

Winter ice storm hazard index* at 30-m resolution shown for Danforth, Machiasport, and Roque Bluffs. Higher ice storm hazard is shown in darker blue, while lower hazard is shown in lighter blue and white.

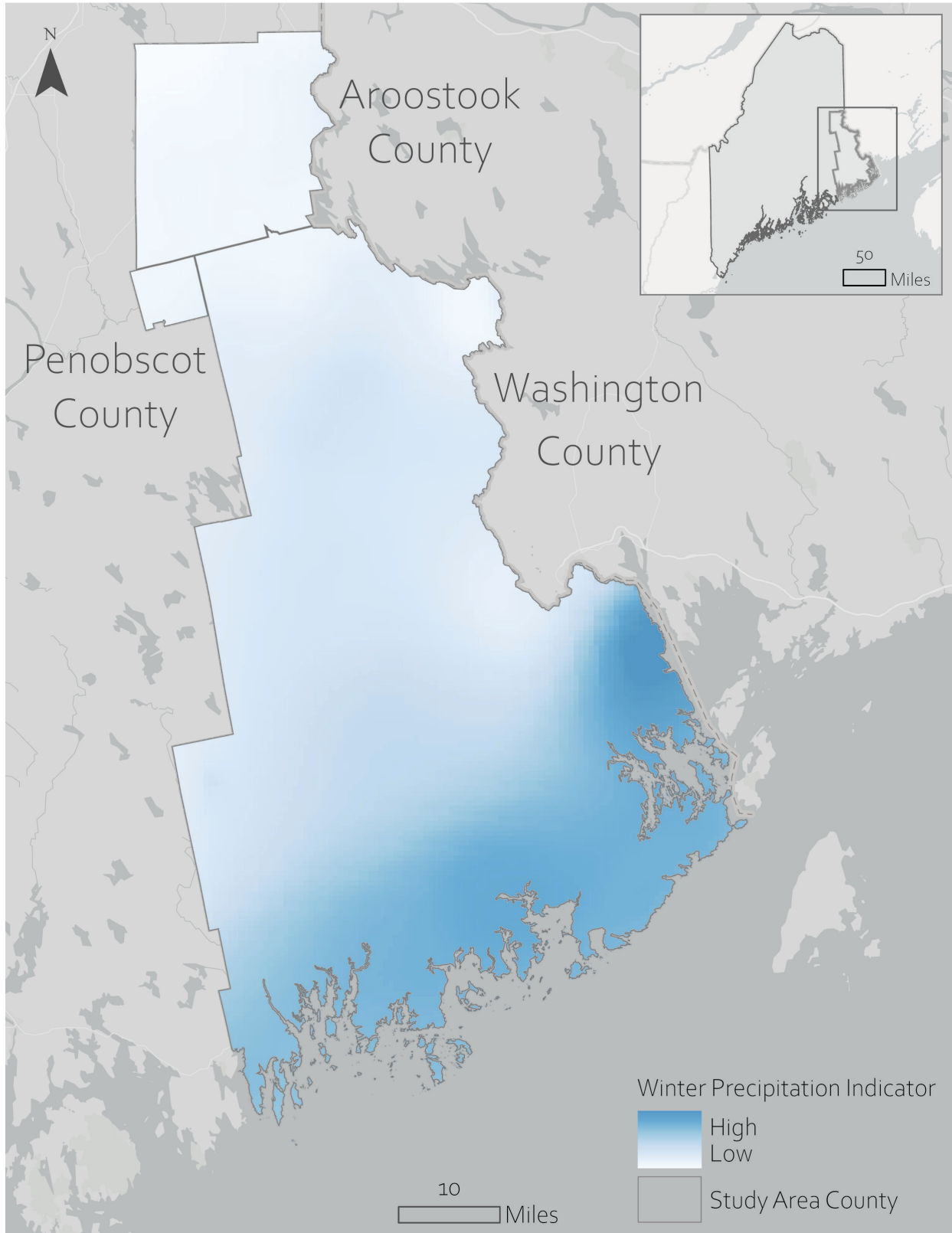
*This index incorporates coarser (800-m) resolution precipitation data (to measure winter precipitation) that were resampled to 30-m resolution for assessment integration.



Elevation indicator at 30-m resolution, derived from a digital elevation model (DEM). Higher elevations that are generally more ice prone are shown in darker blue, while lower elevations that are generally less ice prone are shown in lighter blue and white. This indicator is the first of three indicators for this assessment’s winter ice storm hazard index.

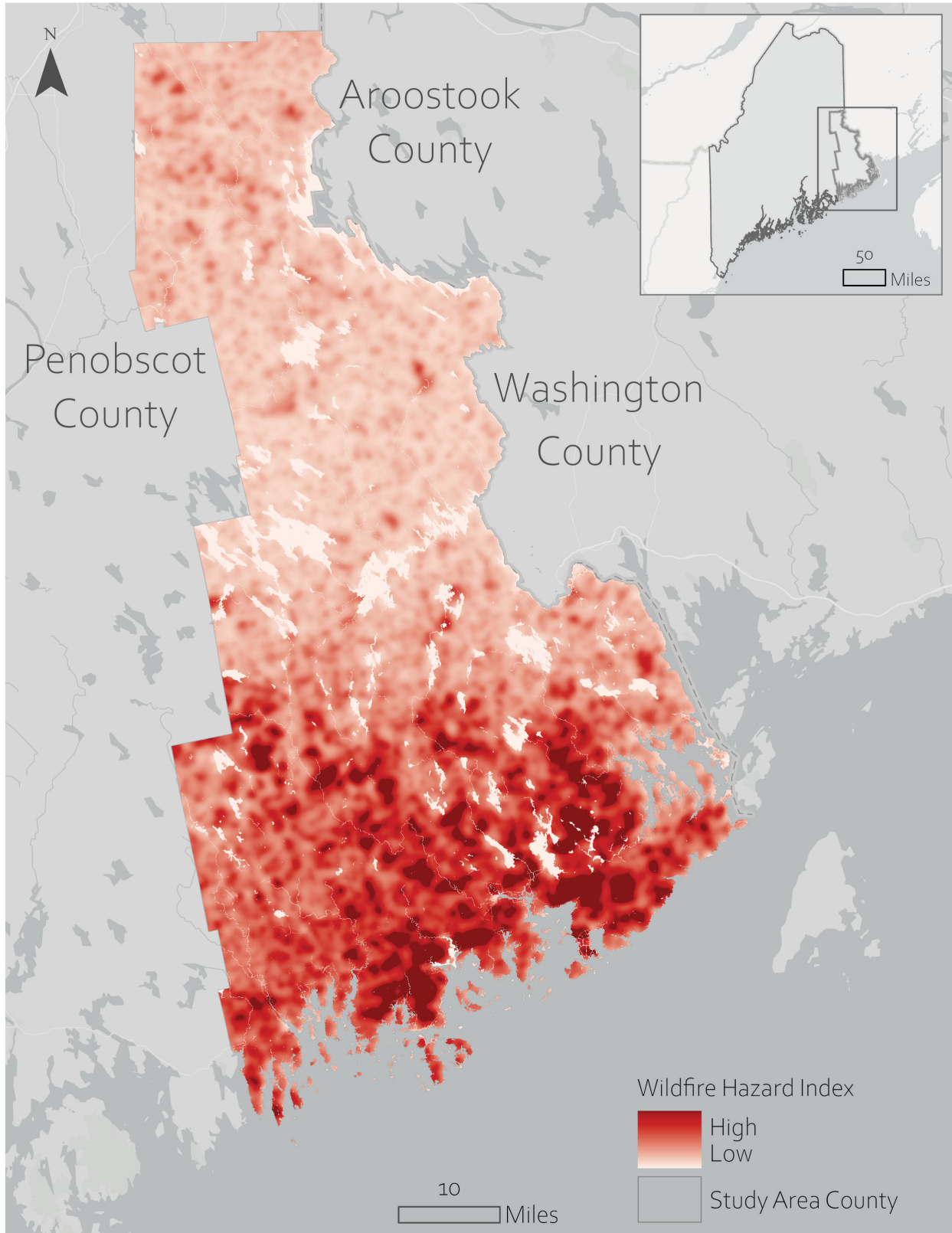


Land use/land cover indicator at 30-m resolution, grouped and reclassified by ice storm damage impact. Land use/land cover types that have higher damage potential from ice accumulation are shown in darker blue, while land use/land cover types that have lower damage potential from ice accumulation are shown in lighter blue and white. This indicator is the second of three indicators for this assessment’s winter ice storm hazard index.



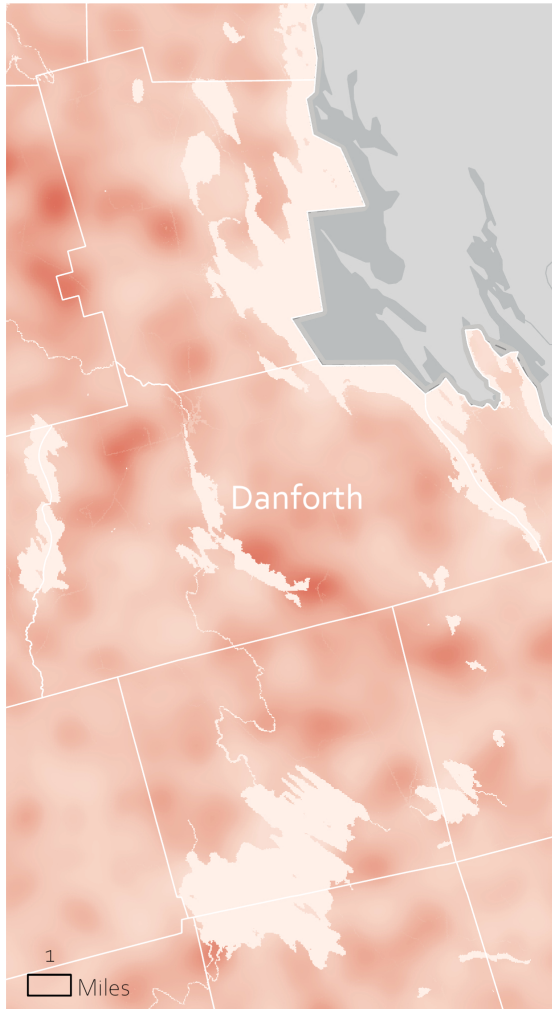
Winter precipitation indicator* at 30-m resolution, by combining precipitation averages from December, January, and February. Higher precipitation is shown in darker blue, while lower precipitation is shown in lighter blue and white. This indicator is the third of three indicators for this assessment’s winter ice storm hazard index.

*This indicator uses coarser (800-m) resolution data that were resampled to 30-m resolution for assessment integration and should be used only to assess broad geographic trends.

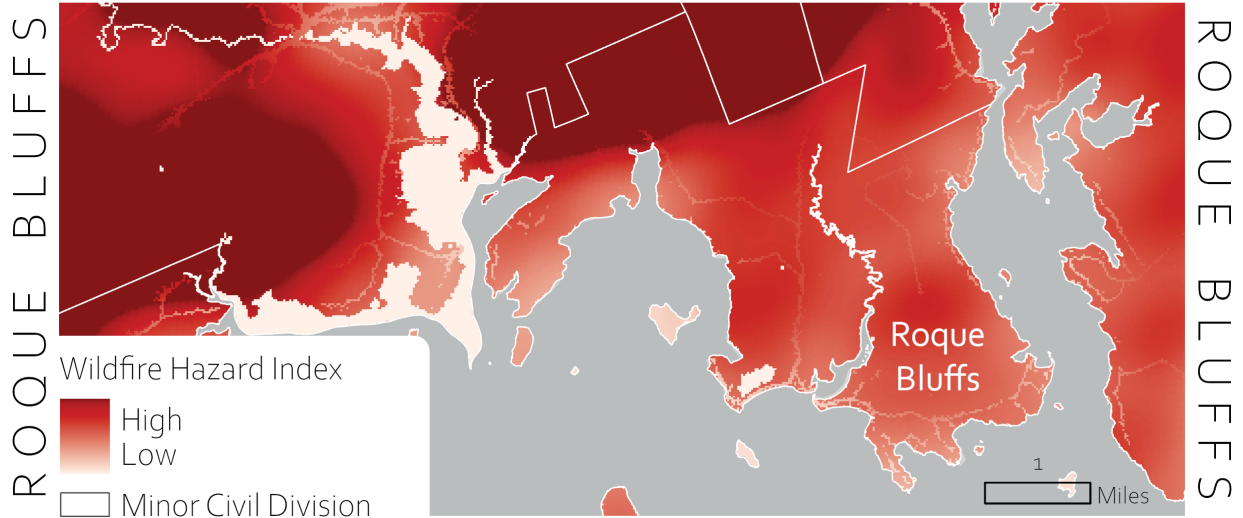
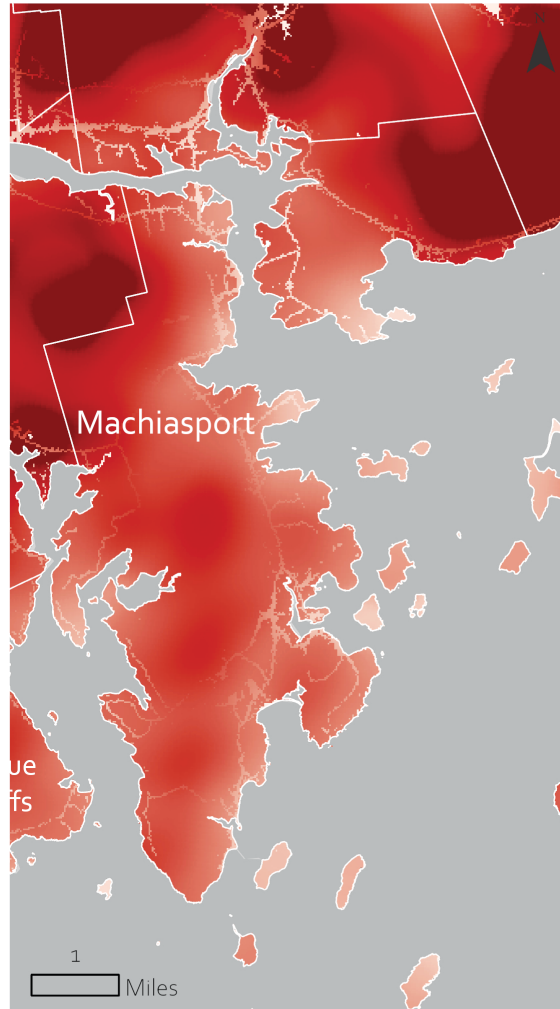


Wildfire hazard index at 30-m resolution. Higher burn potential is shown in darker red, while lower burn potential is in lighter red.

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Wildfire hazard index at 30-m resolution shown for Danforth, Machiasport, and Roque Bluffs. Higher burn potential is shown in darker red, while lower burn potential is in lighter red.

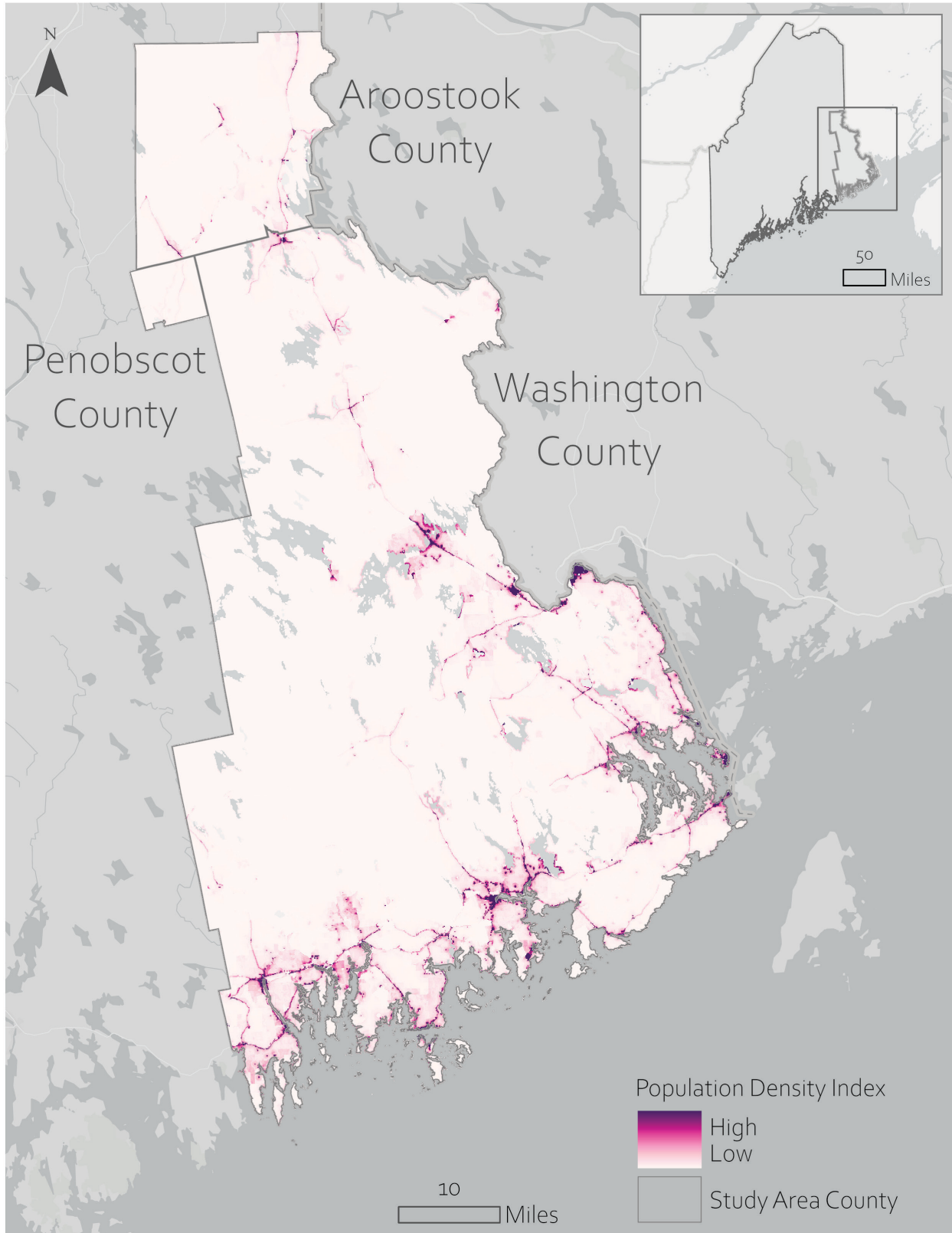
7 Demographic and Structural Components

This section presents population density and critical infrastructure, visualized through points and density mapping. Critical infrastructure types were prioritized by partners, building upon and complementing infrastructure already included in Washington County’s planning maps. Excluding point maps, final index maps are relative to the study area, ranging from lower to higher density. All map values are unitless index values relative to the study area, excluding structural points.

By showing **where people and critical infrastructure are concentrated**, these maps help decision makers **plan strategically and allocate resources to support residents in towns, townships, and more remote areas.**



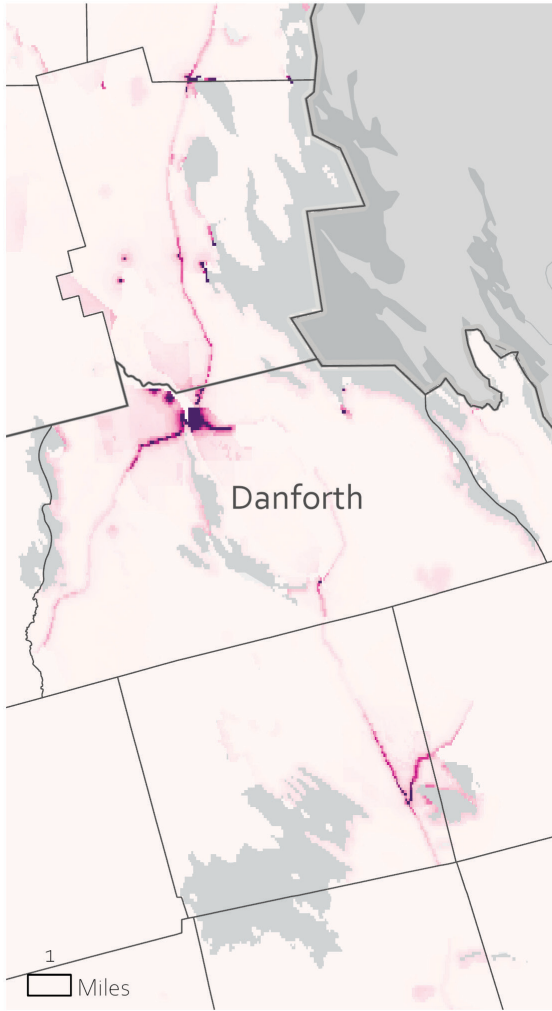
Crab meat for sale in Machias, Maine. Credit: Chloe Fleming, CSS Inc./NOAA NCCOS.



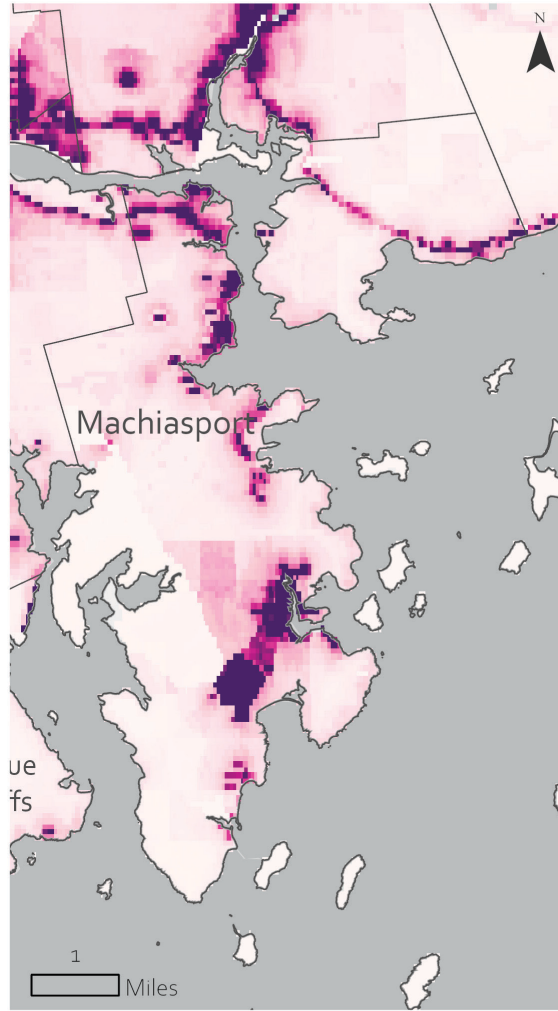
Population density index* between 2000–2020 in 30-m resolution. Higher population density is shown in darker pink and purple, while lower population density is shown in lighter pink and white.

*This indicator uses coarser (100-m) resolution data that were resampled to 30-m resolution for assessment integration and should be used only to assess broad geographic trends.

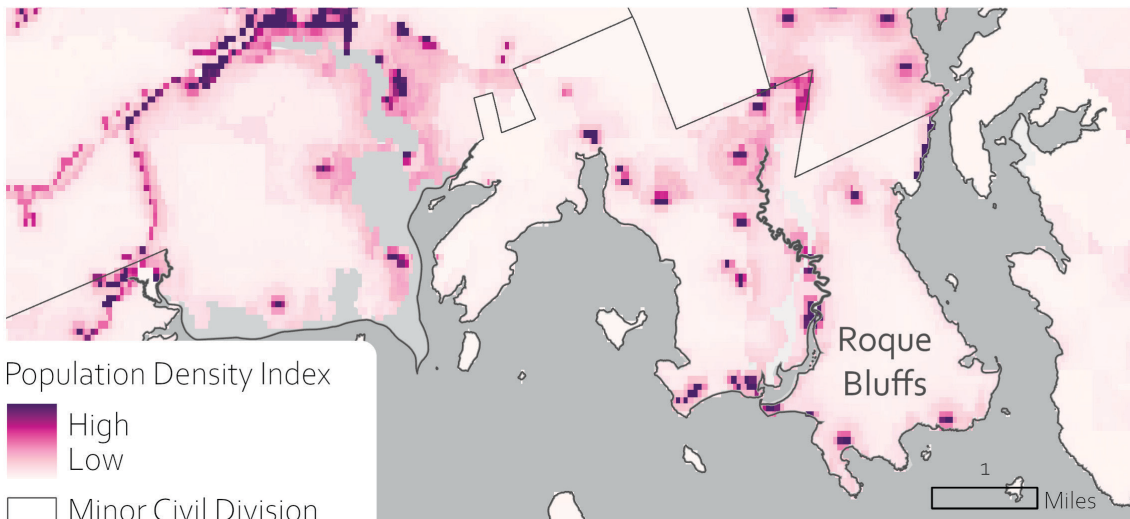
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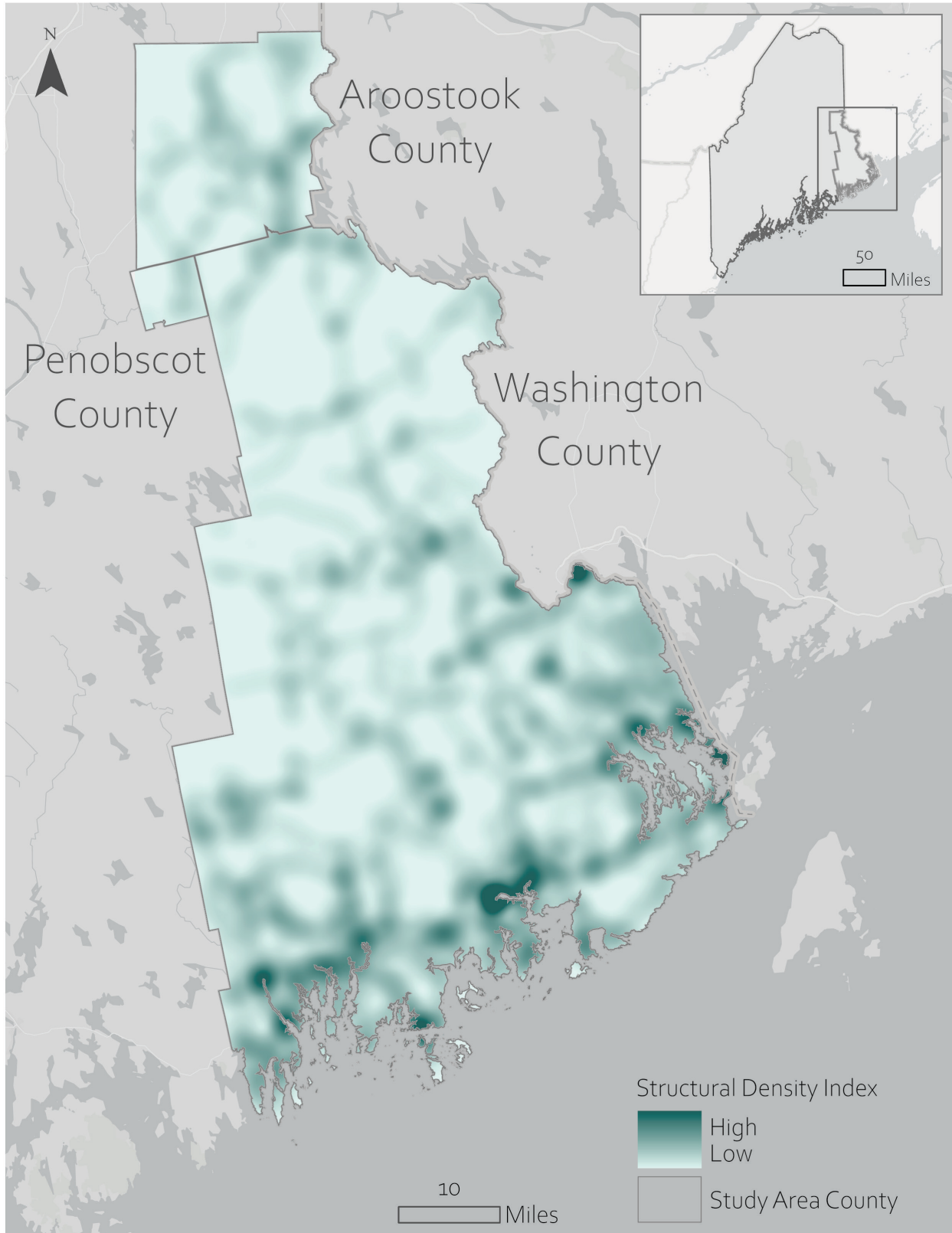


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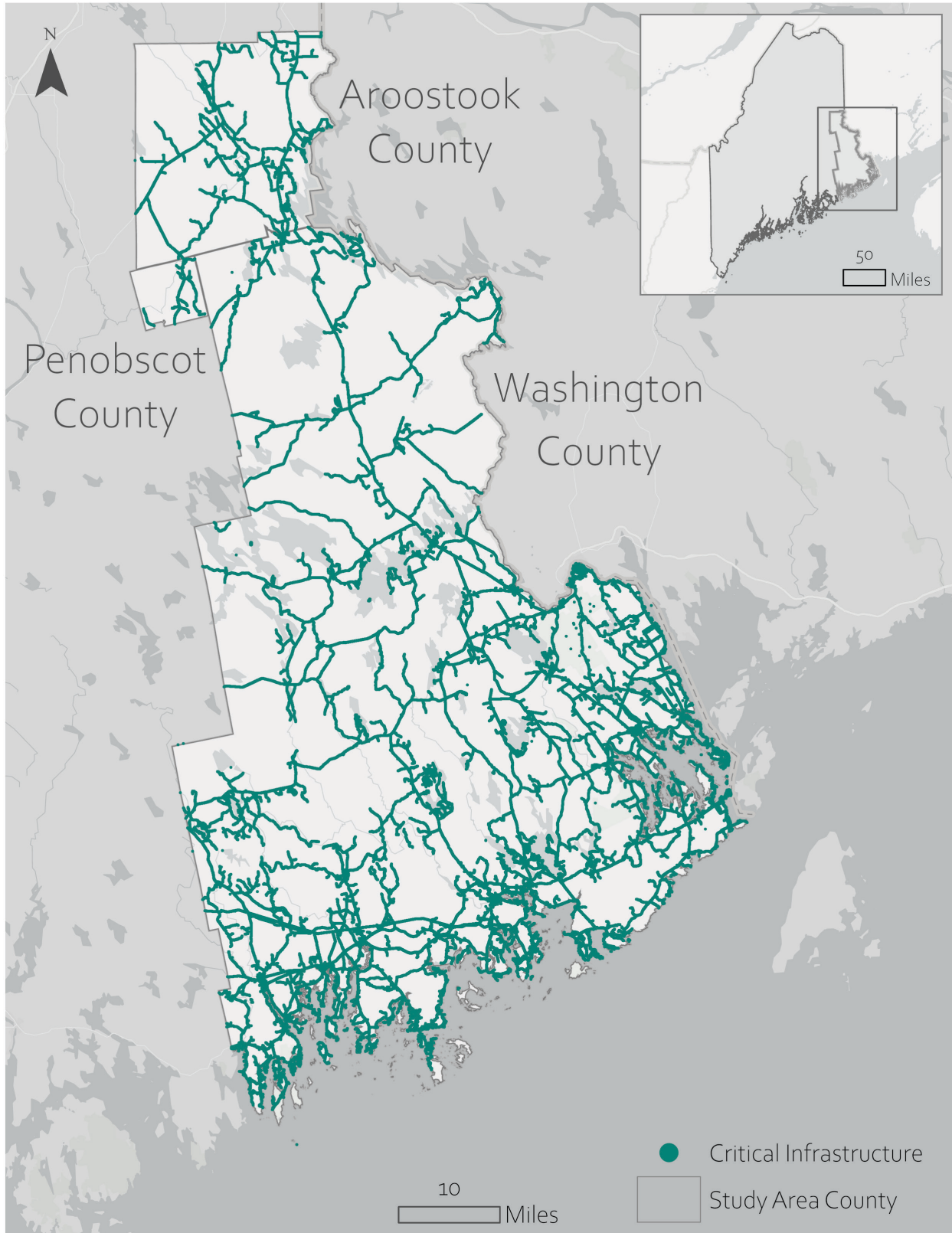
Population Density Index
 High
 Low
 Minor Civil Division

Population density index* between 2000–2020 in 30-m resolution for Danforth, Machiasport, and Roque Bluffs. Higher population density is shown in darker pink and purple, while lower population density is shown in lighter pink and white.

*This indicator uses coarser (100-m) resolution data that were resampled to 30-m resolution for assessment integration and should be used only to assess broad geographic trends.

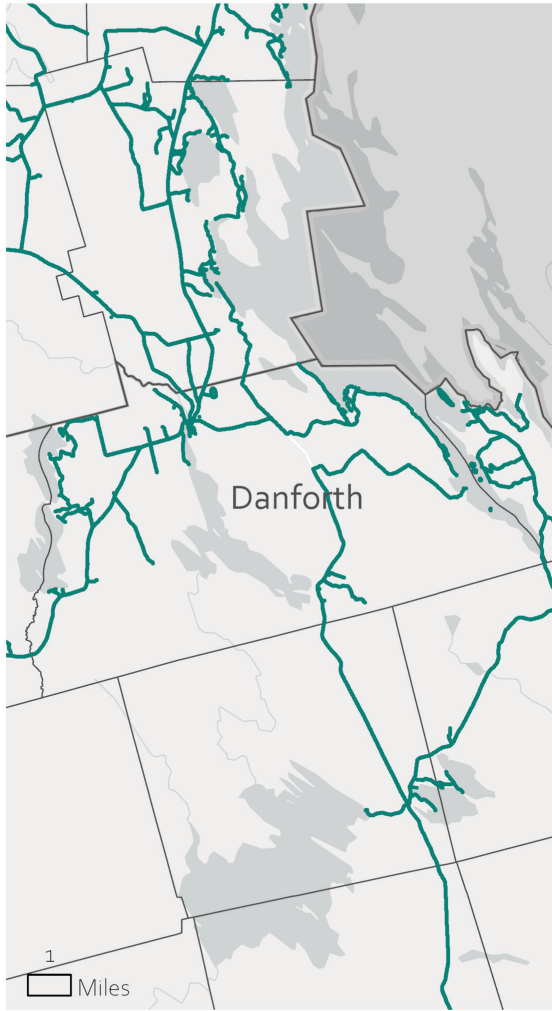


Structural density index in 30-m resolution, based on the critical infrastructure index shown on the next page. Higher critical infrastructure density is shown in darker teal, while lower critical infrastructure density is in lighter teal.

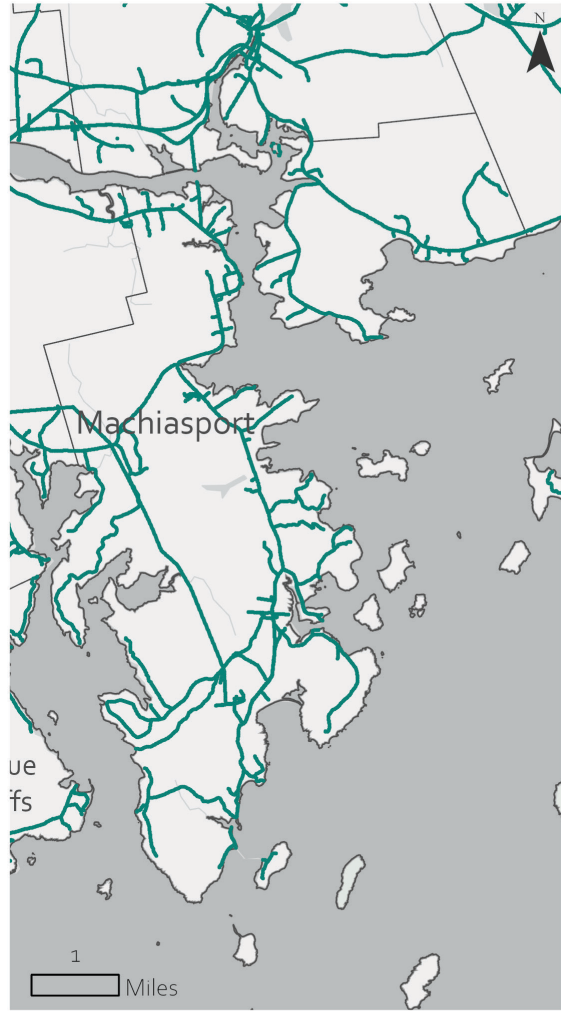


Critical infrastructure points, including emergency medical and management services, hospitals, fire stations, law enforcement and correctional facilities, assisted living and nursing homes, public health and recovery treatment offices, childcare providers, education facilities (early childhood–university), libraries, post offices, grocery and hardware stores, farmers markets, gas stations, laundries, hazardous materials sites, dams, power lines, roads, cemeteries, and cultural and historical sites. Roads were symbolized by points placed every 30 m along roadways.

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Critical infrastructure points shown for Danforth, Machiasport, and Roque Bluffs, including all infrastructure types described on the prior page. Roads were symbolized by points placed every 30 m along roadways.

8 Glossary of Terms

Component: Each analytical category within the risk assessment.

Co-occurrence: An understanding of the overlap between two assessment indices.

Critical infrastructure: Physical systems and assets so vital that their destruction or incapacitation would have a debilitating impact on communities.

Digital elevation model: A quantitative model of terrain, used for deriving surface information like slope, aspect, viewsheds, and watershed boundaries.

Drainage class: A soil classification based on the rate and extent of water removal from a soil profile under natural conditions.

Elevation: The height of a given location above or below mean sea level, informed by a digital elevation model.

Flood: The overflowing of the normal confines of a stream or other water body, or the accumulation of water over areas that are not normally submerged.

Flow accumulation: A measure used to delineate a drainage area by calculating the total upstream area that drains into a specific point on a landscape.



Logging operations in Washington County, Maine. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.



Flea market along Machias dike in Washington County, Maine. Credit: Chloe Fleming, CSS/NOAA NCCOS.

Hazard: An event or condition that may cause injury, illness, or death to people or damage to assets, including loss of property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Hydrologic soil group: A classification that reflects a soil's permeability, infiltration rate, and runoff and transmission potential.

Ice storm: A storm where significant, potentially damaging, ice accumulates from freezing rain.

Index: A quantitative metric that combines one or more normalized indicators to provide a comparative measure relative to the study area.

Indicator: A measurable variable that reflects a key aspect of a system or construct.

Isolation risk: The potential for becoming cut off from essential services and aid, often due to severe weather events impacting critical infrastructure.

Land use/land cover: Land classification types that determine their likelihood of being flood prone or commonly associated with wetlands.

Precipitation: All forms of liquid or solid water that fall from clouds, such as rain, snow, hail, and sleet.

Proximity to drainage networks: The spatial relationship between a feature and a network of streams, rivers, and other watercourses.

Rainfall intensity: A measure of the amount of precipitation within a given amount of time and at peak values that can approximate runoff rates.

Raster: A digital image composed of a matrix of cells (or pixels) arranged in rows and columns, where each cell contains a data value.

Relationship mapping: A mapping technique that displays two variables within the same map and map legend, utilizing graduated color symbols.

Risk: The potential for negative consequences where something of value is at stake.

Routable road network: A digital model of interconnected street segments and junctions that represents the physical road system and supports connectivity analyses.

Service area: A region representing accessible locations within a specific travel time or distance from a facility, defined by a network dataset like a road network.

Slope: The percent change in elevation at a given location, informed by a digital elevation model.

Soil erodibility: An estimate of a soil's susceptibility to erosion by water and wind.

Storm surge: The abnormal rise of sea level accompanying a hurricane or other intense storm.

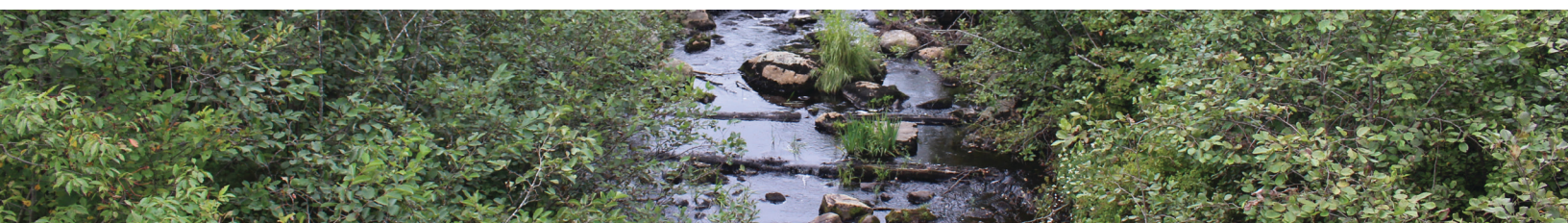
Stormwater: Floods that occur as a result of rainwater.

Washout: The sudden erosion of soil or surfaces by water, often from a heavy downpour or flash flood.

Wind erodibility group: A classification that reflects a soil's susceptibility to erosion caused by wind, based on texture and other physical characteristics.

Wildfire: An uncontrolled fire that burns in wildland vegetation.

Vector: A type of spatial data model that uses points, lines, and polygons to represent geographic features with discrete boundaries defined by coordinate systems.



River in Washington County, Maine. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.

9 Methods and Data

This research project was informed by an in-person workshop and virtual follow-up consultations in 2024. Participants were invited based on expertise, organization, interest, and availability within Washington County and the wider planning region.

All spatial data were processed in ArcGIS Pro version 3.4.0 and clipped using a study-area vector boundary or a 30×30-m raster mask. Data inputs for all analysis presented in this mapbook were available at 30-m resolution or finer, with the exception of population density (100 m) and precipitation (800 m). Resampling does not enhance the intrinsic spatial detail of either of these original datasets (used in the population density, stormwater flooding, and winter ice storm indices). Based on statistical testing and intended partner use, all inputs were retained at a 30-m resolution to ensure spatial congruence and facilitate coherent relative analyses.

Raster outputs were snapped or resampled to a 30×30-m-resolution raster, and vector outputs were presented as points or lines. Indicators were normalized through min-max normalization from 0–1 and categorized into statistical quantile breaks to communicate relative scores across each index.

All methods can be explored in greater detail in the methods report (<https://doi.org/10.25923/jkv3-gw89>), and all derived data are archived with Harvard Dataverse (<https://doi.org/10.7910/DVN/SICI8E>) and www.data.gov.



Blueberry barrens in Washington County, Maine. Credit: Reilee Gunsher, CSS Inc./NOAA NCCOS.

Assessing Community Risk in Relation to Coastal and Inland Natural Hazards in Maine's Washington County and Greater East Grand Region

U.S. Department of Commerce
Howard Lutnick, Secretary

National Oceanic and Atmospheric Administration
Neil Jacobs, Under Secretary for Oceans and Atmosphere

National Ocean Service
Nicole LeBoeuf, Assistant Administrator

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